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Toxicity of Pyrethorids Co-administered with Sesame Oil against Housefly *Musca domestica* L.

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ABSTRACT

The susceptibility of a laboratory reared strain of *Musca domestica* L. to cypermethrin 10 EC, fenpropathrin 20 EC, fenvalerate 20 EC and lambda cyhalothrin 2.5 EC, at different ranges of concentrations (250 to 2500 ppm) of the formulated insecticides in acetone alone and in combination with sesame oil in 1:1 and 1:2 ratio of insecticide: sesame oil was investigated. These concentrations in a volume of 5 mL were added to 25 g of granulated sugar in a petridish. House flies were fed on the insecticide coated sugar for 48 h. Knockdown and mortality data were recorded after 1, 2, 4, 6, 8, 12, 24 and 48 h and subjected to probit analysis. KD_{50} values of cypermethrin, lambda-cyhalothrin, fenpropathrin and fenvalerate in 1:1 ratio with sesame oil were 4297, 17188, 2324 and 8487 ppm, respectively as compared to 1915, 15034, 2608 and 4005 ppm respectively when these insecticides were applied alone. Similar fashion was seen in context of LC_{50} values. The pyrethroid + sesame oil combination in two ratios does not show the synergism in *M. domestica*.

Key Words: *M. domestica*; Pyrethroids; Synergist; Sesame oil

INTRODUCTION

Housefly (*Musca domestica* L.) causes a serious threat to human and livestock health by transmitting many infectious diseases. In view of the severity of the problem, it is imperative that control of houseflies must be improved through the application of occupationally and environmentally safe natural pesticides. Housefly has been successfully controlled by the application of various insecticides, but reports of insecticide resistance, as reported elsewhere in this insect have been amply found (Scott, 1999; Kaufman *et al*., 2001; Shono & Scott, 2004).

Insecticide synergism can be used to control or study insecticide resistance. It contributes significantly to improve the efficacy of the insecticides, particularly when problems of resistance have arisen. Synergists are an important research tool in the laboratory to determine the mechanisms of resistance involved in a particular population (Lorini & Galley, 2000). This kind of investigation has generated valuable information in understanding pesticides resistance. Insecticide synergists have been used not only to monitor the insecticide resistance mechanisms but also as an admixture in these insecticides for the control of many insects including house fly (Hinkle, 2006). Piperonyl butoxide has been used as a synergist with organophosphate and pyrethroid insecticides to control stored grain pests. This compound was isolated from sesame oil (Morris, 2002). Initial trials in the UK proved that sesame extract works well to combat insecticide resistance in pests of greenhouse crops such as tomatoes and cucumbers. In Australia and South Africa trials were successful in cotton against the B biotype of *Bemesia tabaci* Gen. (tobacco whitefly), which is virtually un-controllable with the use of conventional insecticides as well as against cotton aphid (*Aphis gossypii* Glover) (Moore, 2005). Sesamin, a lignan occurring in sesame's seed oil has been reported as synergist insecticide, antisseptic, bactericide (Bedigian *et al.,* 1985). Sesamolin also has insecticide properties (PBeckstrom-Sternberg & Duke, 1994) and is used as a synergist for pyrethrum insecticides (Simon *et al*., 1984). Clove oil has also been used for the purpose in case of a Baygon resistant strain of *Culex pipiens* L. (Salama *et al*., 2002). In Pakistan, neither there is any control program for housefly nor any systematic study on insecticide resistance to organophosphate, carbamate and pyrethroids insecticides. Previously we provided the base line data of insecticidal toxicity on a strain of *M. domestica*, which is the objective of present study (Ahmed & Irfanullah, 2004).

Taking the preceding points into consideration the present work was started to investigate the toxicities of different insecticides to housefly. For this purpose, a laboratory reared strain of housefly was exposed to pyrethroids of different concentrations (250 - 2500 ppm) mixed with sugar. The insecticides were also co-applied with a synergist (100% pure sesame oil) to find out improve the efficacy of the insecticides through feeding technique.

MATERIALS AND METHODS

Insecticides. Trade names, common names, formulations and concentrations of insecticides used in the present study are given Table I.

Rearing of flies. House flies were reared for bioassay at room temperature in the Crop Pest Management Laboratory, Department of Agricultural Entomology, University of Agriculture Faisalabad. Cages, 40 x 40 x 40 cm, used for the rearing of house fly, were covered with mesh screen with cloth sleeve opening at front. The adult flies were maintained in a mesh cage with granulated sugar and milk soaked cotton wool in petridishes. The newly emerged flies were also fed with full fat fresh milk soaked in cotton wool for three days after emergence to enhance egg production. Then they were given milk sugar solution as mentioned above. After three days of fly emergence, the beakers containing larval food were placed for egg lying. The beakers were removed from cages after 2 - 3 days when eggs were visible and attached to food along the sides of beakers. The food was changed after 2 - 4 days depending upon the numbers of larvae per beaker. The beakers were kept in separate cage for fly emergence.

Table I: Trade names, common names and formulation and their concentrations used in the study

Trade name	Common Name	Formulation	Concentration (ppm)
Cypermethrin	cypermethrin	10 EC	250-1000
Karate	Lambda-cyhalothrin	2.5 EC	312-2500
Fenpropathrin	Fenpropathrin	20EC	500-2000
Fenvalerate	Fenvalerate	20EC	500-2000

Larval diet. Larval medium comprised yeast, dry milk powder, wheat bran and water. The beaker was filled with the larval media and put in the cage with flies. After 2 - 3 days these beakers were taken out and a piece of nylon mesh was fastened to their mouth held in position with a rubber band. Larval medium was changed depending upon the number of larvae. When the pupae were formed, these beakers were kept in another cage for adult emergence.

Bioassays. This was done by performing studies with insecticides and synergist. In the former case, a range of concentrations from 250 - 2500 ppm of the formulated insecticides was made in acetone to a volume of 5 mL. A 25 g of granulated sugar and 5 mL of each concentration were put in a petridish, which was left in fume cupboard for overnight to allow the evaporation of acetone. A batch of 50 flies was released in a smaller mesh cage with one concentration of an insecticide. The flies were also provided with same amount of sugar and dried milk in the same cages with insecticide + sesame oil treated sugar.

For studies with synergist, sesame oil was used. Insecticide was mixed with sesame oil in 1:1 and 1:2 ratio to gey KD_{50}/LC_{50} of insecticide + synergist combination. Data on the knockdown effect and mortality were taken after 1, 2, 4, 6, 8, 12, 24 h and 48 h after treatment. KD_{50}/LC_{50} was not consistent after 12 and 24 h and hence analysis was done for these intervals only.

Statistical analysis. The dosage-mortality and knockdown data were analyzed using Probit Analysis (Hewlett & Plackett, 1979) to obtain KD_{50}/LC_{50}, χ^2 value, slope and fiducial limits.

RESULTS

The KD_{50} and LC_{50} values in *M. domestica* after 12 and 24 h exposure of different pyrethroids alone and in combination with sesame oil are given in Table II & III. All the insecticide + sesame oil combinations had high KD_{50} value as compared to insecticide alone except fenpropathrin, in which the KD_{50} (2324 ppm) in 1:1 with sesame oil resembled the value when it was applied alone (2608 ppm). Slope of all insecticides with 1:1 sesame oil combination was more than one, but less than one when insecticides were in 1:2 combinations with sesame oil. LC_{50} values obtained after 24 h exposure also showed high value in insecticide + sesame oil combination than insecticide alone.

DISCUSSION

Insecticide synergism is the type of interaction of insecticide with another chemical, usually of low toxicity, which results in an un-expectedly high mortality. Piperonyl butoxide has been used as a synergist to the pyrethroids for the control of houseflies. There are reports of its residues on some commodities. Residues of pyrethrin-I (Py-I) and pyrethrin-II (Py-II), the major insecticidal components of the pyrethrum daisy [*Tanacetum cinerariifolium* (Trev.) Schultz-Bip.] and residues of piperonyl butoxide (PBO, a pyrethrum synergist) were found in soil and on potato foliage grown under field conditions (Antonious *et al*., 2001). PBO is not effective in all situations as it failed to synergize a number of insecticides (Scott, 1999; Scott *et al*., 2005; Proudfoot, 2005). Surveys carried out for 21 field strains in Denmark showed resistance for bioresmethrin/ PBO, pyrethrin/PBO and dimethioate (Kristensen *et al*., 2001). Although resistance levels against different pyrethroids decreased from spring to fall, these levels still indicated the presence of a strong selective pressure on the populations (Akiner & Çaðlar, 2006).

Various plant oils such as neem oil, castor oil, acorus oil and sesame oil have been used in specific applications as additives for enhancing the efficacy of formulations by synergism. These oils may be ideal substitutes to organic solvents, but at higher concentrations they may cause phytotoxicity and instability to the active ingredients of the formulation. The advantage of sesame oil as a natural synergist to phosphate insecticides has been demonstrated in *Tribolium castaneum* (Herbst) (Khalequzzaman & Chowdhury, 2003). Pongamia oil has been found a natural pyrethroid synergist (Regupathy *et al*., 1999). Combination of fenvalerate + sesame oil caused 69.26% mortality in eggs of *Plutella xylostella* L. (Vastrad *et al*., 2004). Therefore, plant oil was used as a synergist of the activity of pyrethorids against housefly in the present study. The application of the oil by dipping and topical application has been demonstrated in housefly (Sukontason *et al*., 2004).

Very few studies have reported the insecticide toxicity bioassay in *M. domestica* via feeding. This type of bioassay can help to develop an effective baiting system. Pyrethroids have been used with the assumption that they were the least hazardous to the environment. Pyrethroids used in aerosols

Table II. KD_{50} values in *Musca domestica* after 12 h exposure to pyrethroids alone or to pyrethroids + sesame oil (n = 150)

Insecticide:sesame oil	KD_{50}	FL 95%	Fit of probit line	
	ppm		Slope±SE	χ^2
cypermethrin				
1:1	4297	2093-26400	1.29±0.29	0.96
1:2	96024	35645-2333311	0.72±0.35	0.21
Lambda-cyhalothrin				
1:1	17188	6449-398093	1.01±0.27	0.02
1:2	>18547	*	0.63±0.28	0.51
Fenpropathrin				
1:1	2324	1828-3352	1.95±0.26	1.29
1:2	>53271	*	0.53±0.29	0.04
Fenvalerate				
1:1	8487	4114-54096	1.18±0.26	1.50
1:2	>30162	*	0.35±0.25	1.34
Insecticides				
cypermethrin	1915	1311-3865	1.71±0.29	1.16
Lambda-cyhalothrin	15034	6214-182145	1.41±0.28	1.35
Fenpropathrin	2608	1890-4495	1.48±0.23	0.60
Fenvalerate	4005	2015-9015	2.37±0.44	2.56

Table II. LC_{50} in *Musca domestica* after 24 h exposure to pyrethroids alone or to pyrethroids + sesame oil (n = 150)

Insecticide:sesame oil	LC_{50}	FL 95%	Fit of probit line	
	ppm		Slope±SE	χ^2
cypermethrin				
1:1	2382	1324-9285	1.01±0.22	0.09
1:2	23406	8963-43562	0.44±0.21	2.53
Lambda-cyhalothrin				
1:1	7188	2115-10125	0.66±0.20	3.63
1:2	9986	4558-82246	0.95±0.23	0.40
Fenpropathrin				
1:1	2478	1774-4416	1.35±0.22	0.61
1:2	4856	2697-18796	1.03±0.22	0.24
Fenvalerate				
1:1	3733	2269-10712	1.07±0.21	0.83
1:2	22115	5563-1664931	0.67±0.22	0.19
Insecticides				
cypermethrin	1102	815-4506	0.93±0.20	2.87
Lambda-cyhalothrin	10977	5012-25538	0.77±0.21	3.13
Fenpropathrin	3395	2144	1.12±0.21	0.03
Fenvalerate	997	729-1553	0.92±0.19	1.48

provide an instant death of houseflies, but for long lasting and persistent control it is not clear whether pyrethroids can be effective. The insecticide having the least LC_{50} in less time would be considered as the most effective. The pyrethroid + seseame oil combination in two ratios does not show synergism in *M. domestica*. For instance, sesame oil + cyperemthrin in 1:1 and 1:2 had 2382 and 23406 ppm, respectively and 1102 ppm when flies were exposed to cypermethrin alone. Feeding inhibition does not account for higher KD and LC values as housefly was found dead in the petridishes of insecticide + sesame oil combination.

Though suppression of insecticide resistance by sesamex has been observed (Oppenoorth, 1967) but use of sesame oil in pure form lacks this ability. Dilution of oil-based insecticides in sesame oil can be another factor resulting in low efficacy. No published data are so far available parallel to the present studies i.e., feeding method. Therefore, further investigation using other plant oils as synergists may be carried out to confirm the present data.

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