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Laboratory evaluation of four insecticides on the mosquito *Culiseta longiareolata* (Macquart) (Diptera: Culicidae).

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Abstract

The efficacy of four insecticides belonging to different groups, synthetic pyrethroid (lambdacyhalothrin), carbamate (Marshal) , fungicide (Topas) and insect growth regulator (Neemrich) as well as their joint action were tested against 3rd larval instar of *Culiseta longiareolata*. Based on concentration mortality data LC_{50} and LC_{90} values, results obtained showed that LC_{50} values as observed were 0.09, 2.3 , 9.0and 25.0 ppm for lambdacyhalothrin , Marshal , Neemrich and Topas, respectively. The results showed that all mixtures consisted of a 1:1 (v/v) ratio of the LC_{25} of each compound indicated potentiating effect .The highest potentiating effect was achieved by a mixture of co-toxicity factor equaled+100 (lambdacyhalothrin + Neemrich). The lowest potentiating effects were obtained from mixtures of Marshal + Topas and Topas+Neemrich (co-toxicity factor equaled+40) .The tested insecticides completely inhibited the emergence of adults till 0.0078,0.0625,0.25 and 1 ppm for lambdacyhalothrin , Marshal , Topas and Neemrich , respectively ,and the emergence of adults was inversely proportional to the concentration.

Keywords: Insecticides, *Culiseta longiareolata*, Diptera Culicidae

1 Introduction

Cs. Longiareolata (Macquart) ,is a biting nuisance mosquito *in Egypt ,it is a wide spread* species and found in a high population density Kirkpartrick ,(1925), Kenawy & Elsaid ,(1989) and Teleb (1994). *Cs.longiareolata* is also incriminated as a vector of transmitting *Plasmodium Reticulum,* the causative organisms of Malta fever Hewitt,(1940) and intermediate host of avian plasmodia , Gutsevich *et al.*,(1970). Chemical control is an effective strategy used extensively in daily life.

The control of mosquito at the larval stage is necessary and efficient in the integrated approach to mosquito management . Resistance to carbamates has been noted in *Cx.quinquefasciatus*. The use of mixtures to a strategy of rotation over time of insecticides with different modes of action has already made it possible to prevent or to delay the appearance of resistance in the field Martin *et al.*,(2000).However, mixtures of appropriate dosages of unrelated compounds may have better prospects for managing resistance effectively than rotations of the types of compounds. The advantage of mixtures is that each insecticide eliminates most insects which are genetically susceptible to it , Barnes *et al.* , (1995) .However,many authors have already demonstrated the synergistic effect on insect pests of carbamates or organophosphates and pyrethroids ,Koziol & Witkowski, (1982),Ozaki *et al.*, (1984) and Roberston & Smith, (1984) with insects of medical importance, a synergistic effect between pyrethroids and carbamates was reported on larvae of *Cx.quinquefasciatus* ,Corbel *et al* ,(2003) and adults of *Anopheles gambiae* Corbel *et al* ,(2002) susceptible to these insecticides.

Insecticide mixtures have been proposed as an important tools for resistance management in different insect pests (Hemingway and Ranson, 2000).This type of potentiation or synergism is explained by the inhibition of esterases ,Bryne and Devonshire (1991) and Montella *et al.*,(2012) or monooxygenases activity ,Martin *et al*.,(2003).

The present work was carried out to clarify the toxic effect of four insecticides which are regularly used in fields; lambda-cyhalothrin, Marshal, Topas and Neemrich .The interaction between them against the 3rd larval instar of *Cs. Longiareolata* and the effects of these insecticides on emergency of adults.

2 Materials and Methods

Mosquito culture

Cs.longiarolata larvae were collected from wells near Zagazig city in Sharkia Governorate and reared under laboratory conditions (25±2°C and 80±5% relative humidity)for several generations .

Insecticides

Commercial formulations of insecticides used for bioassays are :Pyrethroid (lambda-cyhalothrin) ,Carbosulfan (Marshal 25%) , Topas (with the active compound Penconazole, is a systemic fungicide) and Neemrich. These chemicals obtained from Syngenta Agro Egypt Company - Egypt.

Larvicidal bioassay

For each insecticide seven concentrations were prepared by diluting the formulation product with distilled water in plastic cups (250ml) against the 3rd larval instar of *Cs.longiareolata* .Twenty five larvae were placed in each cup. The test was carried out at the same conditions of rearing. Larvae were left for 24 h and mortality was then recorded and compared with control. Moribund larvae were considered dead. Four replicates per concentration were used. WHO Technique (1996) was used for measuring the susceptibility of larvae to given insecticides. Mortality was corrected according to Abbott formula (1925).

Joint action study

Concentration – mortality curves were established and the LC_{25} values were determined. Binary mixtures were prepared in proportion to their toxicity equivalents of LC_{25}. The combined action of each mixture was expressed as the co-toxicity factor (C.F), estimated according to the equation given by Sun and Johnson (1960) :

$$\text{Co - toxicity factor} = \frac{\text{(\% observed mortality} - \text{\% expected mortality)}}{\text{\% expected mortality}} \times 100$$

A positive factor of 20 or more is considered potentiation , A negative (-20) or more is considered antagonism , and intermediate values ranging between -20 and +20 indicate only additive effect.

Pupicidal bioassay

Ten replicates of newly developed pupae were transferred into plastic cups 10 cm height (4/ cup) containing different concentrations of each of the tested insecticide**.** The number of emerging adults was observed ,calculated daily and compared with control (untreated).

Data analysis

Data obtained from each concentration. Larvicidal bioassay (total mortality) were subjected to probit analysis (Finney, 1971) and LC_{25},LC_{50} and LC_{90} values were calculated .All results were expressed as mean ± standard error, and the data were analyzed using student T-test. Results with $p<0.05$ were considered to be statistically significant.

3 Rresults

Larvicidal bioassay

The results presented in table 1 showed that all insecticides induced mortality on the 3rd larvae of *Cs. longiarolata* .On the basis of LC_{50} values, the larvicidal toxicity of lambda-cyhalothrin was the most potent (LC_{50}= 0.08ppm) followed by Marshal(LC_{50}= 2.4 ppm) , Neemrich(LC_{50}= 8.7ppm) and Topas(LC_{50}= 24.6 ppm),respectively.Similar trend has also been observed for LC_{90} (0.3,11.7,51.7 and 106.3 for lambda-cyhalothrin, Marshal, Neemrich and Topas, respectively.

Joint action study

The interaction of binary mixtures of tested insecticides against the 3rd larval instar of *Cs. longiareolata* is shown in table 2. The calculated "co-toxicity factor" exceeded 20; a results accounting to "potentiation effect" . All the mixtures exhibited potentiation effect. The highest potentiating effect was for mixtures of co-toxicity factor equaled +100 (lambda-cyhalothrin+ Neemrich). The lowest potentiating effects(+40) was obtained from mixtures of Marshal + Topas and Topas + Neemrich.

Pupicidal bioassay

Data concerning pupicidal activity are shown in table 3.The results revealed that all insecticides caused 100% complete inhibition of the adult emergence at 0.0078 ppm, for Lambda cyhalothrin, 0.0625 for Marshal , 1.0 for Neemrich , 0.25 ppm for Topas.The adult emergence increased by dilution ,Zidan *et al*., (1997) found that the synthetic pyrothroid ,cyphenothrin showed complete inhibition of adult emergence of *Cx. pipiens* pupae.

4 Discussion

Kawakami,(1989) tested permethrin against *Cx. pipiens* larvae and found that LC_{50} was 0.01 ppm . Basset *et al*., (1997) found that *Cx.pipiens* subjected to Lambda – cyhalthrin did not develop cross resistant to cypermethrin ,this was in contradiction with Xia *et al* .,(1998) who reported that *Cx.pipiens* resistance to Lambda –cyhalthrin developed 41 and 28 fold resistance to permethrin and cypermethrin, respectively.

There are several studies on mixture toxicities (particularly pyrethroids with other compounds) in different dipteran insect pests worldwide, Since pyrethroids and organophosphates have different modes of action, their mixtures have commonly been in practice against a variety of pests worldwide for the last many years Ahmad , (2009). Previously it has been assumed that organophosphates , when used in combination with pyrethroids, inhibit the enzymes responsible for metabolic detoxification in different insect pests Martin *et al*., (2003) .Corbel *et al*.,(2003) showed that propoxur at LC_{50} significantly enhanced the insecticidal activity of permethrin. Ali Khan *et al*., (2013) showed that most of the insecticide mixtures

Table(1) Efficacy of the four insecticides on the 3rd larval instar of *Cs.Longiareolata*

Insecticide	Lc values (ppm)			Slope function
	Lc_{25}	Lc_{50}	Lc_{90}	
lambda-cyhalothrin	**0.04 (0.25-0.45)**	**0.08 (0.04-0.09)**	**0.3 (0.25-0.42)**	**3.6 ± 0.1**
Marshal	**0.5 (0.1-0.8)**	**2.4 (2.0-3.0)**	**11.7 (10.0-13.0)**	**9.4 ± 0.6**
Neemrich	**3.7 (3.2-4.0)**	**8.7 (8.0-0.9)**	**51.7 (45.0-60.0)**	**22.5 ± 0.8**
Topas	**11.0 (9.0- 13.0)**	**24.6 (22.0-27.0)**	**106.3 (102.0-108.0)**	**3.6 ± 0.1**

Values between brackets are 90% fudicial limits of the corresponding toxicity values. The latter values are estimated from their respective regression lines (LC-P lines).

Table(2) The joint action of four insecticides on the 3rd larval instar of *Cs. Longiareolata*

Binary mixtures	Lc_{25}(ppm) For Compound 1 Compound 2	Observed mortality %	Co-Toxicity Factor
lambda-cyhalothrin1+ Marshal2	**0.04 + 0.5**	**90**	**+80**
lambda-cyhalothrin1+ Neemrich2	**0.04 + 3.7**	**100**	**+100**
lambda-cyhalothrin1+ Topas2	**0.04 + 11.0**	**85**	**+70**
Marshal1 + Neemrich2	**0.5 + 3.7**	**80**	**+60**
Marshal1 + Topas	**0.8 + 11**	**70**	**+40**
Topas 1+ Neemrich2	**11 + 3.7**	**70**	**+40**

like one pyrethroid with other compounds significantly increased the toxicity of pyrethroids in the field population of house flies, *Musca domestica L.*.

In addition, insecticides from pyrethroid and organophosphate classes may be potential or competitive substrates for the same oxidase, as demonstrated by Kulkarni and Hodgson (1980) thus potentiating the toxicity of the insecticide mixture.The pupicidal activity of insecticides was also studied by Fournet *et al*.,(1993),and Trayler *et al* .,(1994).

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Table (3) Pupicidal activity of four insecticides on *Cs.Longiareolata*pupae

Conc.(ppm)	% Emergency of adults (Mean S.E) *			
	Lambdacyhalothrin	Marshal	Neemrich	Topas
1	0.0	0.0	0.0	0.0
0.5	0.0	0.0	12.5 ±3.5*	0.0
0.25	0.0	0.0	31.3±3.5 *	0.0
0.125	0.0	0.0	* 50.0±5.1	12.5±3.5 *
0.0625	0.0	0.0	75.0±5.1 *	31.3± ± 3.1 *
0.0312	0.0	31.3±3.1 *	100.0±0.0	4305±3.4 *
0.0156	0.0	56.3 ±3.1 *	—	56.3±3.1 *
0.0078	0.0	68.8±5.9 *	—	75.0±3.6 *
0.0039	25.0 ±5.1 *	87.5±3.6 *	—	87.5±3.6 *
0.0018	56.3±5.1 *	100.0±0.0	—	100.0±0.0
0.0009	83.3±3.6 *	—	—	—
0.00045	100.0±0.0	—	—	—
Control	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0

***** Significant P=0.05
**Results are the means of ten replicate

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