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Susceptibility of *Culex pipiens* from different locations in Riyadh City to insecticides used to control mosquitoes in Saudi Arabia

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ABSTRACT

Three formulated pyrethroid-based insecticides, Scidco-alpha, Scidco-delta and Restagaurd and their five technical components α- cypermethrin, deltamethrin, tetramethrin, s-bioallethrin and d-phenothrin were evaluated for their effect against the 4th instar larvae of a laboratory and two field strains of *Culex pipiens*, collected from two lcations in Riyadh, Irqa (location A) and El nafl (location B). In addition, two formulated organophosphorus-pyrethroid mixed insecticides (Fenitrothion 55/5 and Combi 25/10) and their technical components (fenitrothion, tetramethrin and fenvalerate) were tested against the above-mentioned strains. The results showed the appearance of tolerance or resistance of field strains to most of these insecticides. In location A the resistance ratios were 7.44, 0.92, 57.7, 2.75, 10, 4.68, 2.3, >29.9, 1.45, 1.19, 2 and 4.01 for Scidco-alpha, Scidco-delta, Restagaurd, α- cypermethrin, deltamethrin, tetramethrin, s-bioallethrin, d-phenothrin, Fenitrothion 55/5, Combi 25/10, fenitrothion and fenvalerate, respectively, while in location B the resistance ratios were 7.67, 1.75, 67.8, 4.5, 8.46, 3.14, 2.55, > 24.9, 2.18, 13.9, 4.1 and 4.5 for the above mentioned insecticides, respectively.

Key words: *Culex pipiens*, α- cypermethrin, deltamethrin, tetramethrin, s-bioallethrin, d-phenothrin, fenvalerate, fenitrothion, resistance.

INTRODUCTION

Mosquitoes transmit many dangerous diseases to man and animals such as malaria, Rift Valley Fever, dengue hemorrhagic fever, yellow fever, filariasis etc. (Gubler and Clark, 1995, Brandling-Bennet and Pinheiro, 1996, Krogstad, 1996 and Roberts *et al.*, 1997). Resistance of mosquitoes to pesticides had appeared worldwide and included all classes of insecticides (Jiang *et al.*, 1985, Kwakami, 1989, Peiris and Hemingway, 1990, Bourgeut *et al*, 1996, Wirth and Georghiou, 1996, Bisset *et al.*, 1997, Nielsen *et al.*, 1997, Cornel *et al.*, 2002).

Approximately 300 millions of the world population are infected by malaria and between 1-1.5 million people die by this disease every year (WHO/CTD, 1998). In 2001, high population of mosquitoes caused many cases of Rift Valley Fever disease in both people and animals in Gazan, Kingdom of Saudi Arabia and huge amounts of pesticides have been and still used in this area, as well as in the rest of the Kingdom. So, it was necessary to study the situation of these pesticides to monitor the development and appearance of mosquito resistance to the insecticides applied by the municipalities, in order to take the right decision in the right time.

MATERIALS AND METHODS

Tested insecticides: Formulated Scidco-alpha (α- cypermethrin, 10 %), Scidco-delta (deltamethrin, 1.5 % + s-bioallethrin, 0.5 % + piperonylbutoxide, 15 %) and Restagaurd (tetramethrin, 2 % + d-fenothrin, 4 % + piperonylbutoxide, 8 %) were products of SCIDCO (The Saudi Chemical, Insecticide and Disinfectant, Co.Ltd), while formulated Fenitrothion 55/5 (fenitrithion, 55 % + tetramethrin, 5 %) and Combi 25/10 (fenitrothion 25 % + fenvalerate 5 %) were products of The Arabian Company for Chemical Products, APCO). Technical α- cypermethrin (98%), deltamethrin (98 %), tetramethrin (94.8 %), s bioallethrin (95 %) and d-phenothrin (93 %) were kindly provided by SCIDCO, fenvalerate (95%) was obtained from APCO and fenitrothion (98 %) was purchased from Green-hound, England.

Test strains:

Susceptible strain: It was obtained from The High Institute of Public Health, Alexandria, Egypt, and was maintained in our laboratory for more than three years.

Field strains: Egg masses were collected from stagnant water in locations A(LA) and Location B(LB) and were allowed to hatch under laboratory conditions; these areas have a history of treatment with commercial insecticides by the municipality of Riyadh to control mosquitoes. Hatched larvae were fed on finely powdered mouse feed until they reached the 4thinstar larval stage.

Larvicidal activity: Twenty mosquito larvae were placed in a 200 ml glass beaker containing 100 ml of distilled water. Test concentrations, dissolved in ethanol, were added to give the required final concentrations and stirred quietly with a glass rod. Each concentration was replicated 3 times. Three controls that received only the solvent were maintained during the test. Dead larvae were counted 48 h after treatment; larvae that did not move when touched with a thin needle were considered dead.

Statistical analysis: Regression equation, LC_{50} , LC_{95} and confidence limits were calculated according to Finney (1971) probit analysis computer program. Resistance Ratio (RR) was calculated according to the following equation:
RR= LC_{50} of the field strain / LC_{50} of the laboratory strain (fold).

RESULTS AND DISCUSSION

Pyrethroid-based insecticides: Table 1 indicates the relative toxicities of the three commercial pyrethroid-based insecticides and their five technical components, α- cypermethrin, deltamethrin, tetramethrin, s-bioallethrin and d-phenothrin. The LC_{50} values of Restaguard against the susceptible, LA and LB strains were 0.0009, 0.052 and 0.061 ppm, respectively, indicating resistance ratios of 57.7 in strain LA and 67.8 in strain LB. Technical tetramethrin showed LC_{50} values equal to o.3, 1.731 and 1.61 ppm against the three strains, with resistance ratios of 4.7 in strain LA and 3.14 in strain LB, respectively. The

Table 1. Toxicity of pyrethroid -based insecticides to 4th instar larvae of Laboratory (S) and field (L A and L B) *Culex pipiens* strains

Insecticide	Strain	LC_{50} (95% FL)in ppm	LC_{95} (95% FL) in ppm	Slope ± E	RR*
α-Cypermethrin	S	0.0012 (0.0011-0.113)	0.0018 (0.0017-0.0021)	9.49 ± 1.25	
	L A	0.0033 (0.0028-0.0044)	0.013 (0.0084-0.0330)	3.26 ± 0.35	2.75
	L B	0.0054 (0.0050-0.0058)	0.0156 (0.0130-0.0189)	3.57 ± 0.09	4.5
Scidco-alpha	S	0.0009 (0.0007-0.0011)	0.0047 0.0030-0.0110)	2.34 ± 0.417	
	L A	0.0067 (0.0055-0.0085)	0.048 (0.029-0.107)		7.44
	L B	0.0069 (0.0062-0.0076)	0.0225 (0.0179-0.0283)	3.19 ± 0.09	7.67
Deltamethrin	S	0.0013 (0.0012-0.0015)	0.0035 (0.0027-0.0048)	3.97 ± 0.502	
	L A	0.013 (0.011-0.016)	0.074 (0.051-0.0130)	2.22 ±0.25	10
	L B	0.011 (0.010-0.012)	0.032 (0.027-0.09)	3.5 ±009	8.46
Scidco-delta	S	0.0051 (0.0044-0.0059)	0.015 (0.011-0.025)	3.41 ± 0.48	
	L A	0.0047 (0.0026-0.007)	0.013 (0.048-0.778)		0.92
	L B	0.0089 (0.0082-0.0096)	0.0189 (0.016-0.022	4.99 ± 0.26	1.75
Ristaguard	S	0.0009 (0.0008-0.001)	0.0021 (0.0018-0.0025)	4.73 ± 0.47	
	L A	0.052 (0.044-0.062)	0.249 (0.179-0.416)	2.43 ± 0.29	57.7
	L B	0.061 (0.055-0.068)	0.205 (0.161-0.261)	3.13 ± 0.08	67.8
Tetramethrin	S	0.37 (0.344-0.401)	0.6240.539-0.818)	7.26 ± 1.19	
	L A	1.73 (1.579-1.901)	4.323 (3.611-5.62)	4.14 ±0.44	4.68
	L B	1.61 (1.51-1.71)	3.43 (2.82-4.37)	4.96 ±0.41	3.14
d-Phenothrin	S	0.201 (0.183-0.218)	0.402 (0.355-0.48)	5.46 ± 0.59	
	L A	> 6			> 29.9
	L B	> 5			> 24.9
s-Bioallethrin	S	0.118 (0.101-0.132)	0.296 (0.246-0.406)	4.12 ± 0.62	
	L A	0.273 (0.257-0.29)	0.418 (0.382-0.478)	8.9 ± 1.05	2.3
	L B	0.301 (0.282-0.321)	0.476 (0.418-0.513)	8.25 ± 2.43	2.55

* RR = Resistant Ratio

LC_{50} values of the second component of Restaguard, d-phenotrin, against the three strains were 0.201, > 6 and >5 ppm, respectively. LA strain was >29.9 fold and LB starin was >24.9 fold resistant than the laboratory strain. Li- Yulan *et al.* (1999) found that a deltamethrin-resistant strain was 58.71 fold resistant to phenothrin and Cheng *et al* (1998) developed a *C. pipiens* strain resistant to tetramethrin. Restaguard contained Piperonyl butoxide (PBO, 15 %), which may contribute to the higher toxicity of the commercial insecticide to the laboratory strain.

In case of Scidco-delta, the LA strain was almost as susceptible as the laboratory strain, while the LB one was slightly more resistant, resistance ratios were 0.92 and 1.75, in sequence. The two field strains were more resistant to technical deltamethrin than they were to Scidco-deta. LA strain was 10 fold and LB strain was 8.46 fold resistant to technical deltamethrin. The two field strains showed resistance ratios of 2.3 and 2.55 fold towards s-bioallethrin.

Resistance ratios to Scidco-alpha and technical alpa-cypermehrin were 7.44, 7.67, 2.75 and 4.5 for LA and LB strains, respectively, Scidcoalpha do not contain PBO. Our LC_{50} for α-cypermehrin against the laboratory strain agrees well with that of Gonzalez *et al.* (1999). Li-Yulan *et al.* (1999) and Cheng *et al.* (1998) selected a *C. pipiens* strain resistant to both deltamethrin and cyperethrin.

Organophoshorus-pyrethroid mixed insecticides: Table 2 reports the toxicities of Combi 25/10 and Fenitrothion 55/5. Resistance ratios to combi 25/10 were 1.19 and 13.9 in LA and LB strains respectively. Technical fenvalerate had LC_{50} values of 0.0022, 0.0089 and 0.0099 ppm against the three test strains, respectively. Fenitrothion 50/5 showed LC_{50} values equal to 0.262, 0.381 and 0.571 ppm, while technical fenitrothion showed LC_{50} values equal to 0.159, 0.319 and 0.653 ppm against the three tested strains, respectively. Tang and Zhang (1993), Kawakami (1989) and Li-Yulan*et al.* (1999) reported about the resistance of *C. pipiens* to fenvalerate and fenitrothion. The results obtained in his study proved that the two field populations of *C. pipiens* collected from Riyadh city have developed tolerance or resistance to most insecticides used to control mosquitoes in Riyadh. It is of great importance to take the suitable decisions to overcome this problem to avoid the outbreak of this serious pest.

Gonzalez,T.,; Bisset, J.A.; Diaz, C.; Rodriguez, M.M. and Brandolini, M.B. (1999). Insecticide resistance in a *Culex quenquefasciatus* strain from Riode Janeiro, Brazil. Mem Inst Oswaldo Cruz, 94 (1): 121-122.

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حساسية الكيولكس بيبينز من مناطق مختلفة فى مدينة الرياض للمبيدات الحشرية المستخدمة فى مكافحة الباعوض فى المملكة العربية السعودية

على سعيد آل- سرار ، حمدى ابراهيم حسين ، ضيف الله الراجحى ، سليمان المحيميد
قسم وقاية النبات - كلية علوم الأغذية و الزراعة - جامعة الملك سعود ص ب ٢٤٦٠
الرياض ١١٤٥١ - المملكة العربية السعودية

تم تقيم فعالية ثلاثة مبيدات حشرية من مجموعة البيروثرويد وهى سكيدوكو ألفا ، سكيدوكو دالتا ، رستجارد ومكوناتها الخام الخمسة : ألفا_سيبرمثرين ، دالتا مثرين ، تترامثرين أس- بيوالثرين والفينوثرين ضد يرقات العمر الرابع من باعوض الكيولكس بيبينزمن السلاله المعملية وسلالتين حقليتين تم جمعهما من موقعين فى الرياض هما عرقة (موقع أ) والنفل (موقع ب).كذالك تم إختبار مبيدين من لبيدات المكونة من مخلوط من مجموعة الفوسفات العضوية ومجموعة البيروثويد وهما فنتروثيون ٥٠ /٥ ، كومبى ١٠/٢٥ ومكوناتها الخام (فنترويثون، تترامثرين، فينفاليدات) ضد السلالات المذكورة. أظهرت النتائج تحمل أو مقاومة السلالات الحقليه لمعظم المبيدات المختبرة ، و كانت نسبة المقاومة فى الموقع(أ) ٧,٤٤ ، ٠,٩٢ ، ٥٧,٧ ، ٢,٧٥، ١٠ ، ٤,٦٨ ، ٢,٣، أكبر من ٢٩,٩ ، ١,٤٥ ، ١,١٩، ٢، ٤,٠١ لكل من سكيدوكو ألفا ، سكيدوكو دالتا ،رستجارد ومكوناتها الخام الخمسة : ألفا- سيبرمثرين ، دالتا مثرين ، تترامثرين ، أس- بيوألثرين ، د- فينوثرين ، فنتروثيون ٥/٥٥ ، كومبى ١٠/٢٥ ، فنتروثيون، فينفاليرات على التوالى -بينما كانت نسب المقاومة فى الموقع (ب) هى ٧,٦٧ ، ١,٧٥ ، ٦٧,٨ ، ٤,٥ ، ٨,٤٦ ، ٣,١٤ ، ٢,٥٥ ، أكبر من ٢٤,٩ ، ٢,١٨ ، ١٣,٩ ، ٤,١ ، ٤,٥ للمبيدات المذكورة على التوالى .