RESPONSE OF THE MOSQUITO *CULEX PIPIENS MOLESTUS* IN THE AMMAN AREA OF JORDAN TO CERTAIN INSECTICIDES

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ABSTRACT. The response of adult females of the mosquito *Culex pipiens molestus* to six insecticides was evaluated. Adults were collected from two locations in the Amman area from May to October 1983. The F_1 generation was exposed to paper-impregnated insecticides using WHO test kits. At both locations, the most toxic insecticides were permethrin, propoxur and ferpropathrin. Malathion, dieldrin and DDT were far less effective.

INTRODUCTION

Culex pipiens molestus Förskal is the most widely spread mosquito in the Middle East (Barkai et al. 1967, Sacca 1973, Bar-Zeev et al. 1974, Ramahi 1980). Sacca reported that the mosquito problem in Jordan starts near the beginning of the hot season. Breeding may occur in tanks where water is stored, particularly when such tanks are not properly covered. In addition, it also occurs in gutters near the street pavement where disposed water accumulates, below manholes where the sewerage system exists and in wadis where most of the impounded water is collected.

More than 250 tons of public health insecticides are imported every year (Anonymous 1983). The bulk of this is used in the Amman area. Organochlorine (OC) insecticides, e.g., BHC, DDT, dieldrin and lindane were used in the 1960s. However, DDT is still used by the Malaria department (Anonymous 1982). In the 1970s, organophosphorus (OP) insecticides used included: dichlorovos, dimethoate, fenitrothion, fenthion, malathion and trichlorphon. Also, carbamates like carbaryl and propoxur were used. In 1980, public health authorities had shifted to the use of pyrethroids, e.g., cypermethrin, decamethrin, permethrin and others (Anonymous 1981a, 1981b, 1982, 1983).

The volume of work in Jordan on susceptibility/resistance of public health insects to insecticides is small. DDT sprays were introduced in 1949 to curb fly-borne diseases, ophthalmia and dysentery, in the United Nation refugee camps in Jordan and other neighboring countries. Sprays were successful at first but failed later in the season (Brown and Pal 1971). Resistance of the house fly in the Amman area to several OC, OP and carbamate insecticides was reported (Sacca 1973, Brooke and Martin 1975, Anonymous 1979). Resistance of *Anopheles sergentii* to dieldrin and HCH was reported (World Health Organization 1980). Also, *Cx. pipiens* Linn. in Israel was resistant to several OC and OP insecticides. Seven insecticides belong to OP and carbamates were tested against the larvae of *Cx. pipiens*. All compounds showed an effectiveness which is rather below their usual performance (Sacca 1973).

This research investigated the response of *Cx. p. molestus* collected from two different locations in the Amman area to six insecticides representing four main groups of compounds.

MATERIALS AND METHODS

COLLECTION AND REARING. Adults of *Cx. p. molestus* were collected from Abu-Alanda and Royal Horse Racing Club (RHRC), 12 km. apart, between May and October 1983. They were reared at the University of Jordan insectary at 25 ± 2°C and R.H. of 80 ± 10%. The method of Ramahi (1980) to produce the F_1 generation, for subsequent laboratory tests, was followed.

INSECTICIDES. Six standard test papers (12 × 15 cm) impregnated with different groups of insecticides were used in the tests. The World Health Organization (WHO) furnished the test papers. Insecticides and the concentrations used were: DDT (0.25, 0.5, 1.0, 2, 4%), dieldrin (0.05, 0.1, 0.2, 0.4, 0.8%), propoxur (0.1%), fenitrothion (1.0%), malathion (5.0%) and permethrin 40:60 (0.25%).

TOXICITY TESTS. The method of the World Health Organization (1970) was followed, using standard test kits. Females of the F_1 generation, 3–6 days old, were used. For OC insecticides, mosquitoes were exposed to different concentrations using the standard exposure period of 1 hr. Mosquitoes were exposed to the supplied concentration of other insecticides for different exposure periods of time. Mortality was recorded after 24 hr. Five concentrations of OC insecticides and 5 exposure periods (15, 30, 60, 120, 240 min) for others were tested. Four replicates using 25 mosquitoes each, for each concentration or exposure time were used. Thus, 500 female adults were used to establish each dosage-mortality regression (ld-p) line. Female mosquitoes handled in the same manner but

exposed to standard oil-treated paper served as controls.

STATISTICAL ANALYSIS. The ld-p lines were eye-fitted using Finney's probit analysis method (Finney 1971). For DDT and dieldrin, the LC_{50}, LC_{90} and their confidence limits, slope and its standard error were calculated. For other insecticides, the LT_{50}[1], LT_{90} and their confidence limits, slope and its standard error were calculated.

Since no susceptible strain of *Cx p. molestus* was maintained in our laboratory, or available in Jordan, the CT[2] values in percent-minutes were used to compare the effectiveness of the tested insecticides (Busvine 1958, Variaratnam and Brown 1969). Confidence limits of the CT values were used to determine the significant differences between treatments within the same location. Combined data analysis was performed as outlined by Little and Hills (1978) to analyze significant insecticide-locations interaction. Abbott's formula was not applied since control mortalities were below 5%.

RESULTS AND DISCUSSION

The response of adult mosquitoes collected from the two locations in the Amman area to the tested insecticides is presented in Table 1. For mosquitoes collected from the Abu-Alanda, the ascending order of the CT_{50} values was as follows: permethrin (6.25), propoxur (15), fenitrothion (58), malathion (150), dieldrin (180) and DDT (240). The CT_{50} value for permethrin differed significantly from the other insecticides. There was a significant difference between propoxur and fenitrothion and they differed significantly from the rest. There was no significant difference between DDT and dieldrin. The CT values and slopes of the ld-p lines (Table 1) indicated that the tested population was susceptible and homogeneous to permethrin, propoxur and fenitrothion, followed by malathion. As for dieldrin and DDT, the tested population was far less homogeneous and susceptible than the leading three insecticides.

The CT values for mosquitoes collected from the Royal Horse Racing Club arranged in ascending order were: permethrin (10), propoxur (19.5), fenitrothion (80), malathion (195), dieldrin (210) and DDT (240). The CT values for permethrin, propoxur and fenitrothion differed significantly from each other and the rest. There was no significant difference between malathion, dieldrin and DDT. The CT values and slopes of the ld-p lines (Table 1) indicated that the tested population was homogeneously susceptible to permethrin, propoxur and fenitrothion, followed by malathion. While the population was far less homogeneous and susceptible to DDT, it showed heterogeneity in its response to dieldrin.

Analysis of variance for the CT_{50} values showed a significant difference in the response of the tested population to the same insecticide at the two locations. Generally, the insecticides were more effective at the Abu-Alanda than at the RHRC. This could be attributed to heavier use of insecticides at the RHRC than at Abu-Alanda. Permethrin was leading in its effectiveness at both locations followed by propoxur and fenitrothion. This could be attributed to the recent use of permethrin which only started in 1980 (Anonymous 1983). DDT and dieldrin were the least effective insecticides at both loca-

Table 1. Comparison of different parameters to six insecticides tested against the mosquito *Culex pipiens molestus* collected from two locations in the Amman area.

Insecticide	Royal Horse Racing Club			Abu-Alanda		
	$CT_{50}^{1} \mp CL^{2}$	$b \mp Sb^{3}$	Y^{4}	$CT_{50} \mp CL$	$b \mp Sb$	Y
DDT	$240 \mp 55.2^{*cd}$	1.25 ∓ 0.16	$4.25 + 1.25X$	240 ∓ 63.6^{e}	1.15 ∓ 0.16	$4.31 + 1.15X$
dieldrin	210 ∓ 67.2^{d}	0.85 ∓ 0.1	$4.54 + 0.85X$	180 ∓ 48.6^{de}	1.03 ∓ 0.10	$4.51 + 1.03X$
fenitrothion	80 ∓ 8.62^{c}	3.08 ∓ 0.23	$-0.85 + 3.08X$	58 ∓ 6.98^{c}	2.57 ∓ 0.19	$0.48 + 2.57X$
malathion	195 ∓ 43.1^{e}	2.59 ∓ 0.21	$0.88 + 2.59X$	150 ∓ 20.95^{d}	2.26 ∓ 0.2	$1.66 + 2.26X$
permethrin	10 ∓ 1.33^{a}	2.29 ∓ 0.19	$1.34 + 2.29X$	6.25 ∓ 0.8^{a}	2.52 ∓ 0.22	$1.47 + 2.52X$
propoxur	19.5 ∓ 2.29^{a}	2.69 ∓ 0.21	$1.16 + 2.69X$	15 ∓ 1.69^{b}	2.92 ∓ 0.21	$1.37 + 2.92X$

[1] CT is the concentration X time of exposure in percent minutes.
[2] Confidence limits (CL) calculated at 5% level probability.
[3] Slope F standard error.
[4] Equation of dosage-mortality line.
* Figures followed by the same letter in the same column are not significantly different at the 0.05 level of probability.

[1] LT_{50} is the lethal time of exposure that kills 50% of the tested mosquitoes.
[2] CT is the concentration X time of exposure.

tions. Several reports pointed out resistance of the house fly to OC compounds (Brown and Pal 1971, Anonymous 1979) but no documentation regarding resistance of *Cx. p. molestus* to this group of insecticides is available. However, Sacca 1973 reported that several OP and carbamate insecticides were below their usual performance against this pest.

ACKNOWLEDGMENTS

Thanks are due to the Deanship of Graduate Studies of the University of Jordan for funds to support this research, and to WHO for their supply of test kits and insecticide-impregnated papers. The authors acknowledge the technical guidance and facilities offered by Prof. Elias Saliba in rearing the mosquitoes.

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