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Response of the House Fly *Musca domestica* L. (Diptera: Muscidae) in the Central Jordan Valley to Eight Insecticides

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ABSTRACT. The response of a susceptible strain of the adult house fly *Musca domestica* L. to eight insecticides was determined. Two organophosphorus (OP) insecticides, fenthion and propetamphos, five pyrethroid (PY) insecticides: cyfluthrin, cypermethrin, permethrin (cis: trans, 25:75), permethrin (cis: trans, 40:60), and d-tetramethrin, and one carbamate (C) insecticide, propoxur, were under investigation. The field house fly population was slightly tolerant to propetamphos followed by fenthion of the OP insecticides, with Resistance Factors (RFs) of 3.55x and 7.61x, respectively. For pyrethroid insecticides, the fly showed various degrees of tolerance to cypermethrin, permethrin 25:75 and permethrin 40:60, with RFs of 4.19 x, 6.14 x and 8.18x, respectively. On the other hand, the house fly was slightly resistant to cyfluthrin and d-tetramethrin with RFs of 10.84 x and 28.12x, respectively. For the carbamate insecticide propoxur, the RF was 15.24 indicating that the house fly population was slightly resistant and rather homogenous in its response to this insecticide. The population of the house fly was found to have various degrees of homogeneity with tolerance or resistance to the tested insecticides. The field population is still least tolerant to propetamphos and cypermethrin. However, all insecticides with RFs less than 10 can still be used for the control of the house fly.

The common house fly *Musca domestica* L. has been known to cause nuisance to people all over the world wherever livestock are kept or garbage accumulates. This fly is a typical synanthropic one. It depends on human settlements and activities, including the keeping of domestic animals. It feeds on, and breeds in human waste and manure of animals. Also, it uses human buildings for shelter (Keiding 1986).

The importance of the house fly as a public health problem is due to the fact that it can transmit the causative agents of many diseases such as *Ascaris lumbricoides, Entamoeba histolytica, Salmonella typhi, S. paratyphi, Shigella dysenteriae* and *Polimyelitis virus* (Mallis 1969, Harwood and James 1979).

Resistance of pests to pesticides is a phenomenon that typically develops rapidly. House fly resistance to organochlorine (OC), organophosphorus (OP), carbamate (C) and pyrethroid (PY) insecticides is an international problem (Chapman and Morgan 1992). It can progress within just a few seasons to a point at which dramatic change in control strategies becomes necessary. As a result of the development of resitance, pesticides application costs have been increasing and compel a switch to generally more expensive chemicals and/or more frequent applications.

House fly has been noticed to become a great problem in the Jordan Valley (JV) since intensive farming is spreading all over the valley. This induced farmers to increase the application of both chemical and natural fertilizers including poultry, cattle and sheep manure. The practice, in addition to favorable weather conditions, facilitates the development of the house fly population to high levels. Large amounts of insecticides were imported annually for controlling insects of public health importance such as house flies, mosquitoes, cockroaches, *etc.* Despite these spraying programmes, complaints about the increasing numbers of house fly were rasied. The objectives of this study were to determine the level of resistance of the house fly strain collected from the central Jordan Valley to eight insecticides that belong to three main groups. These groups are carbamates, organophosphorus, and pyrethroids. The response of a susceptible house fly strain to the above mentioned insecticides was used as a standard.

Materilas and Methods

House fly strain and maintenance

A laboratory susceptible strain and a field collected strain of the house fly *M. domestica* L. were tested with eight different insecitcides. The susceptible strain was supplied by ICI Chemical Co., Ltd., UK. This strain was reared at the insectary for a whole year during this study. The field strain was collected from the Jordan University Research Station at the central JV. It was reared in the insectary to give rise to the first generation (F1), which was used in the experiments.

Identification of the house fly

Samples of the collected house flies have been sent to the British Museum for

identification. They were taken from the station at different intervals during this study. This was done to confirm that the flies present in that area were of the same species. Different samples including larvae, pupae and adults of the tested flies were sent to the museum. All stages were identified as stages of *Musca domestica* L.

Rearing of the house fly

Insectary

The house flies were reared in the insectary, Faculty of Agriculture, University of Jordan. This insectary included a wooden cabin that could be opened, and closed tightly. The cabin has the following dimensions: height 200 cm, width 115 cm, and depth 75 cm. It is divided horizontally into two equal parts and each part accommodates three rearing cages. The cabin was provided by a heater and a fan, both connected with a thermostat to give a constant temperature of 27 ± 2°C (Harris *et al.* 1982). It is also provided with a light source which gives a photoperiod of 14:10 with the light commencing at 6 AM. This has been achieved by using a timer. Moreover, the cabin was provided with a thermohygrograph which measures the relative humidity and temperature, usually 70 ± 5% and 27 ± 2°C, respectively (Golenda and Forgash 1985, Hinkle *et al.* 1985). The 70 ± 5% RH was achieved by filling trays at the bottom of the cabin with water.

Rearing cages

Six wooden frame cages were used for rearing the house flies, each cage measuring 35 x 35 x 35 cm. The front and floor of the cages were made out of wood (Nazer and Al-Azzeh 1986). The floor has a 3 cm diameter opening which is closed by mean of a removable rubber stopper. This opening was used to clean wastes that accumulated on the floor. The front of the cage has an opening 20 cm diameter with a cloth sleeve taped over that opening. The three other sides of the cage and the top are covered with a fine mesh wire screen. Moreover, the top of each cage was covered by a translucent plastic cover to prevent any contamination from the outside (Sawicki and Holbrook 1961).

Feeding house flies

Feeding the larvae

Media for rearing the larvae of the house fly were prepared as follows: 100g of wheat bran were mixed with 50g of chicken broiler diet in a 2 litre glass beaker. After that, 150 ml of water was added. The components were mixed thoroughly. Components of the chicken broiler diet were: 64.44% corn, 27.73% Soybean, 5.05% Fish powder, 1.62% di-Calcium Phosphate, 1.21% Ca CO_3, 1.30 salts and 0.11% vitamines. About 1000 eggs were transferred to the glass beaker. This number was

measured by using a 5 mm diameter glass tube which has been marked to a certain height (Anonymous 1977). The beaker which held the eggs was first marked and then covered by a minute pore nylon-netting cover. This is done to prevent any contamination of the medium. After 36-48 hrs when most eggs hatched, a 3-5 cm layer of sand was added to the top of the medium of larvae to pupate in.

Feeding the adults

Newly emerged adults were given water using cotton pads in 200 ml glass beaker provided with a piece of polystyrene to keep the cotton pads floating at the top of surface. The cotton pads were changed every 2 days. Flies were fed a diet composed of two parts of defatted powdered milk and one part of sugar. About five days after emergence, adult females matured and started laying eggs. A Petri dish with a piece of cotton immersed in the oviposition diet was placed in the rearing cage for females to lay eggs on. The oviposition diet was composed of two parts of defatted milk and one part of sugar. This mixture was dissolved in water to give a 5% solution. Eggs laid within 16 hrs were inoculated in the larval medium to produce the adults that were used in the tests (Anonymous 1977).

Separation of pupae

When the larvae matured and were about to pupate, they moved to the sand layer which is cooler and drier than the larval medium. The pupae were placed in Petri and transferred to the rearing cages (Anonymous 1977).

Collection of the house fly from the field

The larval rearing medium was also used to collect the house flies from the field. Beakers containing the media were placed near the cattle barn. After about 2 hrs, the beakers with the flies inside were carefully covered with a fine nylon netting, transferred to the insectary and placed in the rearing cages. The covers were removed to release the flies inside the cages. The beakers were then removed and an oviposition diet was provided for egg laying. Later, eggs were transferred to a new larval medium. After about 2 weeks of eggs seeding, the adults emerged and a new generation was obtained. Morphological characters were used for the identification of the flies before insecticide application.

Insecticides

Insecticides were obtained from WHO. They included two OP insecticides, fenthion 99.5% and propetamphos 98.5%, five PY insecticides: cyfluthrin 94.2%, cypermethrin 91%, permethrin (cis: trans, 25:75) 95%, permethrin (cis: trans, 40:60) 91.6%, and d-tetramethrin 94.5%, and one C insecticide, propoxur 99.6%.

The tested insecticides were dissolved in butanone to prepare the following stock solutions (WHO 1981): fenthion 5%, propetamphos 2%, cyfluthrin 1%, cypermethrin 0.5%, permethrin (both isomers) 1%, d-tetramethrin 2%, and propoxur 16%.

Stock solutions were kept in the freezer at – 4 °C (WHO 1981, Roushi and Wright 1986). Appropriate series of dilutions of these insecticides were prepared using acetone (Table 1) as suggested by WHO (1981).

Table 1. Used concentrations of the tested insecticides

Insecitcides	House fly strains*	Concentrations (ppm)							
Fenthion	S	20	30	40	50	75	100		
	F	50	100	250	500	1000	1250	4000	
Propetamphos	S	20	40	80	160	320	400		
	F	50	100	250	500	1000	2000		
Cyfluthrin	S	5	10	15	30	45	90		
	F	25	50	100	250	500	1000	4000	
Cypermethrin	S	5	12.5	25	50	100	150		
	F	25	50	100	250	500	1000	1500	
Permethrin 25:75	S	10	15	25	50	75	100		
	F	25	50	100	250	1000	2500		
Permethrin 40:60	S	10	15	25	50	75	100		
	F	25	50	100	250	500	1000	2500	
d-Tetramethrin	S	10	15	30	40	60	100		
	F	25	400	1000	2000	4000	8000		
Propoxur	S	200	300	400	500	600	800		
	F	400	600	1600	4000	8000	16000	32000	80000

* House fly strains are the susceptible strain (S), and the field collected strain (F).

Toxicity procedure and mortality assessment

Adult flies 3-6 days old (Chapman 1985, Scott and Georghiou 1985) were anaesthetized with carbon dioxide at 4 PSI (Pascal Per Square Inch) for 3 min. The anaesthetized flies were placed in Petri dish for sexing (Nazer and Al-Azzeh 1986). Batches of 30 adult females were separated and placed in a 200 ml cup provided with a sponge at its base to prevent excess humidity. Each cup was covered with a nylon-netting with an opening in the middle. A piece of cotton soaked with 5% sucrose solution was inserted in the opening from which the adult females could feed. Cups were transferred to an incubator (FORMA SCIENTIFIC DIURNAL GROWTH CHAMBER) at 20 ± 2°C and 70 ± 5% RH (WHO 1981). The RH was controlled by providing water in trays. Mortality due to 3 min. anaesthetization was recorded after 24 hrs. Later, adult females were anaesthetized again for 4 min at 4 PSI for topical application of insecticides. Dilutions of insecticides were applied to the thorax of adult females using disposable capillary micro applicators of 1 µl size (Golenda and Forgash 1985). 25 adult females were picked individually by hand and the insecticide was applied to the thorax. The treated flies were transferred to the incubator (Respicio and Heitz 1983). Mortality was recorded after 24 hrs by touching each fly with the tip of pen. Flies unable to move were considered dead.

For each insecticide, at least 6 concentrations were used. Thus, for each concentration a total of 150 adult females were used, and the minimum of 750 adult females for each insecticide. For every insecticide, four types of controls were used. These are: controls for anaesthetization 3 min, and 4 min, respectively; control for using acetone as solvent; and controls for natural mortality. Appropriate concentrations for each insecticide were determined by testing two widely ranging concentrations for each insecticide. The other concentrations were determined according to percent mortality that was shown by the first two concentrations.

Statistical analysis

The LC_{50} (lethal concentration that kills 50% of the tested individuals) and its confidence limits were calculated by using a BASIC computer program modified by Lieberman (1983). Input data included: dose; number of insects; number of insects that responded. The data were fed to an APPLE II computer and the calculated results were obtained, including the regression line slope, and its intercept, the LC_{50}, its confidence intervals, and the chi square (χ^2) values. Abbot's formula was not used because the percentage of control mortality was less than 5% (WHO 1976).

Resistance factor

The Resistance Factor (RF) was used to determine the degree of susceptibility of resistance. It is defined as the LC_{50} of the field collected strain divided by the LC_{50} of the susceptible strain (Sacca 1973b, Keiding 1976, Motoyama *et al.* 1980).

Results

1. *Susceptible strain*

Comparison between the $LC_{50's}$ in ppm of the tested insecticides on the susceptible strain (Fig. 1) shows that the lowest concentration for cyfluthrin is 15.68, followed by permethrin 40:60 (20.16), permethrin 25:75 (25.83), d-tetramethrin (31.91), fenthion (38.51), and propetamphos (66.11). The highest LC_{50} was found to be for propoxur (360.06). The insecticide with the lowest LC_{50} does not indicate that it is the best one, because there are other factors that should be taken into account, especially the homogeneity or heterogeneity of the fly population to the tested insecticide.

The slope of regression lines for the tested insecticides in a descending order were: propoxur (6.01), fenthion (5.27), d-tetramethrin (4.05), permethrin 25:75 (4.02), cyfluthrin (3.29), permethrin 40:60 (3.28), cypermethrin (3.13), and propetamphos (2.84) (Fig. 1, Table 2). As the slope of the regression line becomes higher, the insect population is considered as more homogeneous. On the other hand, as the slope decreases the insect population shows a wide range of heterogeneity. When the regression line is greater than one, the insect population is said to have various degrees of homogeneity to the tested insecticides. On the other hand, when the regression line slope is less than one, the insect population is said to be heterogeneous to that insecticide (Ward and Tan 1977). Accordingly, all tested susceptible strains of *M. domestica* L. exhibit various degrees of homogeneity.

2. *Field collected strain*

The response of the field strain to the different concentrations of insecticides that have been applied, showed a high degree of variation (Fig. 2). The lowest concentration in ppm used to kill 50% of the tested house flies was shown by cypermethrin (108.28) followed by permethrin 25:75 (153.63), permethrin 40:60 (164.86), cyfluthrin (170.03), propetamphos (234.61), fenthion (292.93), and d-tetramethrin (897.46) (Table 2). The highest concentration was found to be for propoxur (5486.64 ppm).

Regression lines slopes in descending order were: fenthion (2.86), propetamphos (2.53), propoxur (1.94), d-tetramethrin (1.67), permethrin 25:75 (1.50), permethrin 40:60 (1.46), cyfluthrin (1.45), and cypermethrin (1.44) (Table 2).

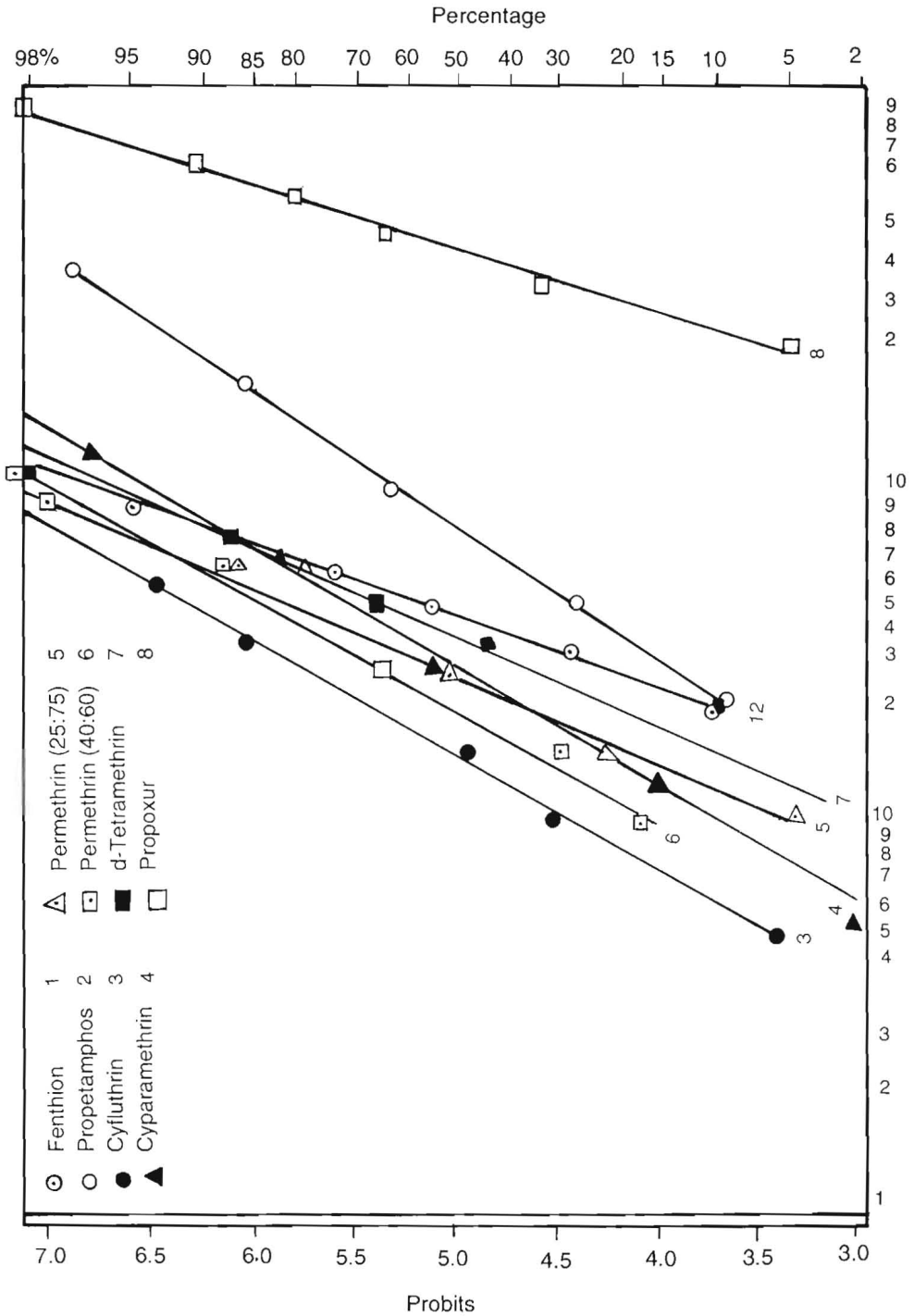

Fig. 1. Dosage mortality lines (Regression lines) for tested insecticides on the susceptible house fly *Musca domestica* L.

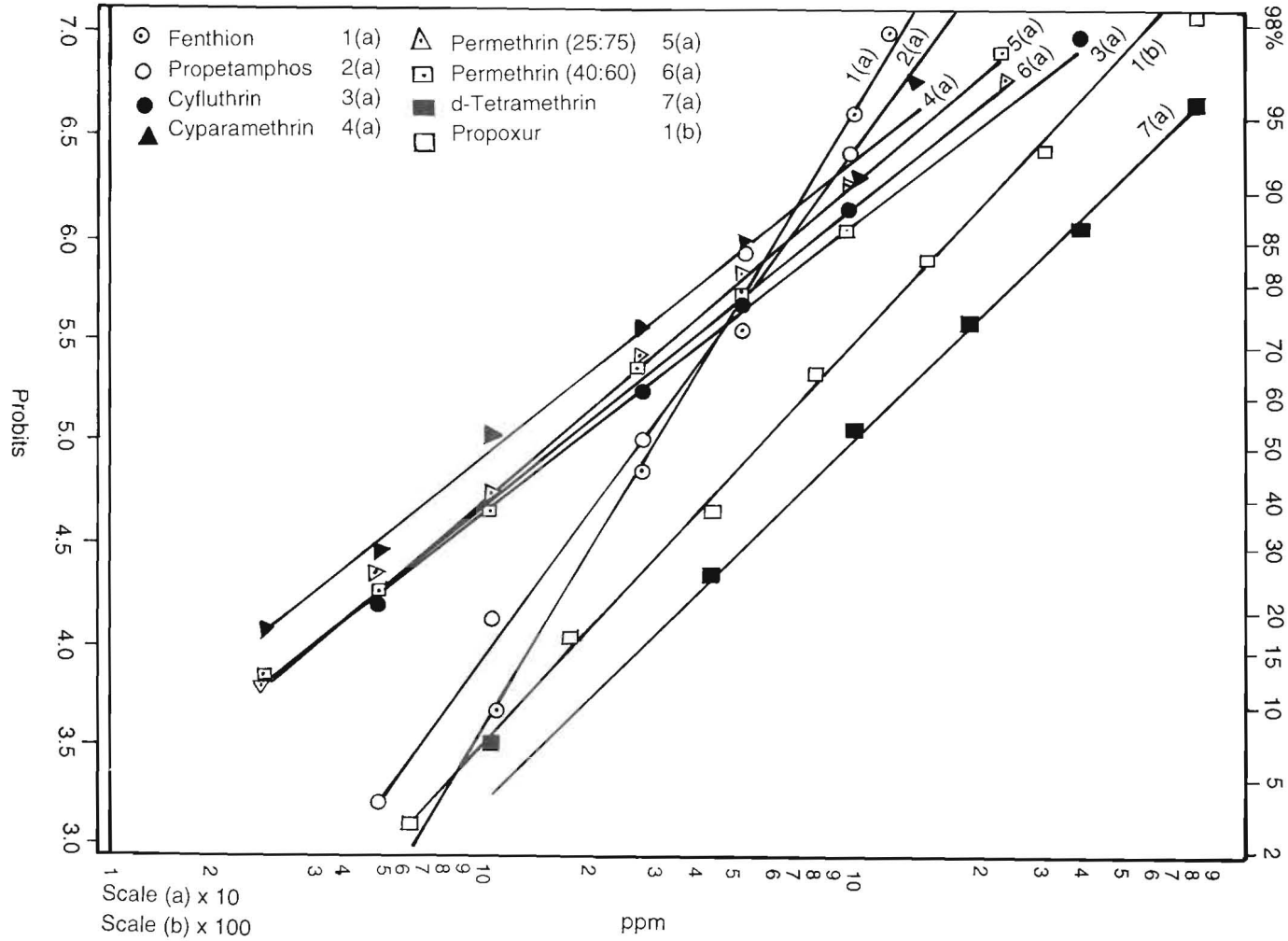

Fig. 2. Dosage mortality lines (Regression lines) for tested insecticides on the field collected house fly *Musca domestica* L.

Table 2. Comparison of different parameters for the susceptible and the field collected house fly strains

Insecticide	Fly strain	LV_{50}[(1)]	CI[(2)]	LC_{50}	CI	Slope ± SE[(3)]	RF[(4]
Fenthion	Susceptible Field	0038.51[f] 0292.93[m]	0036.58 - 0040.47 0264.34 - 0323.43	0.046[f] 0.349[m]	0.034 - 0.048 0.315 - 0.385	5.27 ± 0.33 2.86 ± 0.17	7.61
Propetamphos	Susceptible Field	0061.11[g] 0234.61[l]	0059.71 - 0072.94 0209.62 - 0261.93	0.079[g] 0.279	0.071 - 0.087 0.249 - 0.312	2.84 ± 0.17 2.53 ± 0.14	3.55
Cyfluthrin	Susceptible Field	0015.68[a*] 0170.03[ijk]	0014.14 - 0017.04 0144.99 - 0918.86	0.019[a*] 0.202[ijk]	0.017 - 0.020 0.173 - 0.237	3.29 ± 0.20 1.45 ± 0.09	10.84
Cypermethrin	Susceptible Field	25.83[dc] 0108.28[h]	0023.44 - 0028.39 0091.38 - 0126.83	0.031[dc] 0.129[h]	0.029 - 0.034 0.108 - 0.151	3.13 ± 0.20 1.44 ± 0.09	4.19
Permethrin 25:75	Susceptible Field	0025.03[c] 0153.63[i]	0023.27 - 0026.92 0131.51 - 0178.66	0.030[c] 0.183[i]	0.029 - 0.032 0.157 - 0.213	4.02 ± 0.22 1.50 ± 0.09	6.14
Permethrin 40:60	Susceptible Field	0020.16[b] 0164.86[ij]	0018.49 - 0021.85 0140.86 - 0192.19	0.024[b] 0.196[ij]	0.022 - 2.026 0.168 - 0.229	3.28 ± 0.20 1.46 ± 0.09	8.18
d-Tetramethin	Susceptible Field	0031.91[e] 0897.46[o]	0029.80 - 0034.12 0767.58 - 1041.62	0.038[e] 1.068[o]	0.036 - 0.041 0.913 - 1.239	4.05 ± 0.25 1.67 ± 0.10	28.12
Propoxur	Susceptible Field	0360.06[n] 5486.64[P]	0343.61 - 0376.23 4832.48 - 6223.65	0.428[o] 6.529[P]	0.409 - 0.448 5.751 - 7.406	6.01 ± 0.37 1.94 ± 0.10	15.24

1- Lethal concentration that kills 50% of tested individuals in ppm.

2- Confidence intervals for LC_{50} at 0.05 level of probability.

3- Slope and its standard error.

4- Resistance Factor = LC_{50} of the field strain divided by the LC_{50} of the susceptible strain.

* Figures followed by the same letter are not significantly different to 0.05 level of probability.

When the RF is less than two, the insect population is considered to be susceptible. On the other hand, when the RF ranges between 2-10 the insect population is said to have various degrees of tolerance. If the RF is more than 10, the insect population is considered to have various degrees of resistance (Kensler and Streu 1967, Keiding 1976).

For the OP insecticides the tested house fly population was found to be tolerant for both propetamphos and fenthion with a RF of 3.55x and 7.6x, respectively. Also, for the tested PY insecticides, the insect was tolerant to cypermethrin, permethrin 25:75, permethrin 40:60, and slightly resistant to cyfluthrin and de-tetramethrin. The RFs were 4.19x, 6.14x, 8.18x, 10.84x, and 28.12x, respectively. Moreover, the strain was found to be resistant to the C insecticide propoxur, with a RF of 15.24x.

The field collected house fly strain was found to be homogenous to eight tested insecticides with various degrees. The highest homogeneity was found to be for fenthion, and the lowest was found to be for cypermethrin.

As the value of intercept of the regression lines increased with a positive value, the $LC_{50's}$ in ppm become low, and the insecticides become more efficient.

Referring to Table 2, numbers followed by the same letter are not significantly different at 0.05 level of probability. Depending on the overlapping of the confidence interval (CI) of the insecticides, we see that none of the CI of both the suceptible and the field strains overlap. This means that the insecticides for both susceptible and field strain are significantly different at 0.05 level of probability. Comparison of the CI of the LC_{50} of the susceptible strain, showed that cypermethrin is not significantly different from permethrin 25:75 while the other $LC_{50's}$ of the tested insecticides were significantly different.

Comparisons of the $LC_{50's}$ of the field collected house fly strain, showed that cypermethrin has the lowest CI and is significantly different from the other tested insecticides at 0.05 level of probability. On the other hand, permethrin 25:75, permethrin 40:60, and cyfluthrin are not significantly different at the same level of probability. Moreover, the other OP insecticides (fenthion and propetamphos), PY (cypermethrin and d-tetramethrin), and C (propoxur) are significantly different from each other at 0.05 level of probability.

Discussion

Results indicated that RFs ranged between 3.55 to 28.12 (Table 2). The reasons behind the low RFs for both OP insecticides could be due to the fact that these two insecticides were not used for public health purposes in the JV.

On the other hand, PY insecticides were used frequently in every campaign that has been carried out to control the house flies. The question arises as why the tested fly had tolerance to OP insecticides despite the fact that they were not used in any control campaign. There are three possibilities for the development of tolerance or resistance. The first one depends on the fact that selection pressure with PY insecticides enhances the development of resistance to OP insecticides as has been reported by several investigators (Chapman *et al.* 1993, De Vries and Georghiou 1980, Golenda and Forgash 1985, Scott and Georghiou 1985, Funaki and Motoyama 1986). Also, it is reported that selection pressure of the house fly with C insecticides enhances cross resistance to OP inseciticides (Brown and Pal 1971). The second possibility is that tolerance development to OP insecticides could be a result of the use of agricultural insecticides (WHO 1976). The third possibility is that tolerant house flies have moved from neighbouring farms across the Jordan River.

The most important reason for the development of tolerance or resistance to cyfluthrin, cypermethrin, and permethrin in the JV is the selection pressure with these insecticides (Anonymous 1989). This is in agreement with results reported by several researchers. De Vries and Georghiou (1980) observed that selection pressure with bioresmethrin (RF = 86x), resulted in the development of cross resistance to 16 tested PY insecticides with RFs that ranged between 14x for s-allethrin and 63x for fenvalerate. Also Funaki and Motoyama (1986) showed that selection pressure by resmethrin that inducted a RF of 2931x caused a cross resistance to permethrin and fenvalerate with RFs of 435x and 2143x for both insecticides, respectively. Golenda and Forgash (1985) reported similar results indicating that selection pressure with both cis and transisomers of permethrin produced cross resistance to fenvalerate. Moreover, the high level of resistance to d-tetramethrin is most probably due to the fact that this insecticide is used in control campaigns, in combination with other PY insecticides to ensure knock down effect (Anonymous 1989a).

On the other hand, PY resistance may be a result of using OP, and C insecticides (Brown 1971, De Vries and Georghiou 1980). Keiding (1976) showed that selection pressure with OP insecticides, mainly the use of dimethoate, increases cross resistance to PY insecticides. In the JV, no official reports indicate that organochlorine (OC), OP, or C insecticides have been used in the control campaigns,

but the OC insecticide DDT is used by health authorities to control mosquitoes in anti-malaria campaigns.

For propoxur which is a carbamate insecticide, while referring to the lethal concentrations, we see that the $LC_{50's}$ for the susceptible and the field collected strain in ppm is equal to 360.06 and 5486.64, rspectively. This value compared with other insecticides seems to be high. Thus, for the safe use, precautions must be followed before using this insecticide. The development of resistance to this insecticide could be related to the usage of PY insecticides since the selection pressure with the latter enhances the development of resistance to the former. Funaki and Motoyama (1985) showed that the selection pressure with resmethrin produced 163 fold resistance to propoxur. Also, selection pressure using permethrin increased the RF to methomyl from 3.8x to 11.9x. On the other hand, the use of C insecticides such as carbaryl in agriculture may facilitate the development of resistance to carbamates used in public health (WHO 1976). Moreover, selection with OP compounds increases tolerance to C insecticides (Brown and Pal 1971).

Like in pyrethroids, the use of C insecticides in the form of aerosols to control household insects indoors might be a factor in the increased resistance to propoxur. In 1987 a mixture of dichlorvos and propoxur has been imported to be used for control of household insects (Anonymous 1989b).

In Jordan, Sacca (1973b) showed that the house fly in Amman area was resistant to DDT, and gamma-HCH with RFs of 105x, and 10x, respectively. Also, the house fly was tolerant, resistant, or susceptible to bromophos, fenthion, malathion, pirimiphosmethyl, and tetrachlorvinphos with RFs of 10x, 15x, 33x, 2.5x and 1x, respectively. Sacca reported that the house fly was tolerant to propoxur and resistant to fenthion.

The house fly susceptibility in two locations in the Amman area to different insecticides was measured. The house fly was found to have developed resistance to OC insecticides (DDT, dieldrin and lindane), and to OP insecticides (Dimethoate, diazinon, and dichlorvos). Meanwhile, the house fly was found to be tolerant to the PY insecticides (deltamethrin and permethrin). On the contrary, the house fly in both locations was found to be susceptible to the OP insecticide bromophos and to the PY insecticide d-phenothrin. The house fly developed tolerance to the insecticide permethrin with RFs of 7.0x and 7.3 in the two locations (Nazer and Al-Azzeh 1986). This is in agreement with this study. The two isomers of permethrin were found to have RFs of 6.14x and 8.18x.

References

Anonymous (1977) *Laboratory Rearing Methods and Insect Pests.* Dept. of Pesticides Res., Sumitomo Chemical Co. Ltd. Tokyo, Japan, 7 p.

Anonymous (1989a) *Annual Reports 1981-1989. Ministry of Municipalities and Environment,* Amman, Jordan, (In Arabic) 90 p.

Anonymous (1989b) *Annual Reports 1985-1988. Dept. of Pesticides, Ministry of Agriculture,* Amman, Jordan, (In Arabic) 45 p.

Brown, A.W.A. (1971) Pest Resistance to Pesticides, *In: Pesticides in the Environment.* (**ed.**) by **Stevens, K.W.,** Marcel Dekker, Inc., New York, 1971, **1**(2): 457-552.

Brown, A.W.A. and **Pal, R.** (1971) *Insecticide Resistance in the Arthropods.* 2nd (**ed.**), WHO, Geneva, 491 p.

Chapman, P.A. (1985) The resistance to eighteen toxicants of a strain of *Musca domestica* L. collected from farms in England. *Pesticide Science,* **16:** 271-276.

Chapman, P.A. and **Morgan, C.P.** (1992) Insecticide resistance in *Musca domestica* L. from Eastern England. *Pesticide Science.* **36:** 35-45.

Chapman, P.A., Learmount, J., Morris, A.W. and **McGreevy, P.B.** (1993) The current status of insecticide resistance in *Musca domestica* in England and Wales and the implications for house fly control in intensive animal units. *Pesticide Science.* **39:** 225-235.

De Vries, D.H. and **Georghiou, G.P.** (1980) A wide spectrum of resistance to pyrethroid insecticides in *Musca domestica* L. *Experientia,* **36:** 226-228.

Funaki, E.M. and **Motoyama, N.** (1986) Cross resistance to various insecticides of the house fly selected with pyrethroid. *J. Pesticide,* **11:** 219-222.

Golenda, C.F. and **Forgash, A.J.** (1985) Fenvalerate cross resistance in a resmethrin selected strain of the house fly (Diptera: Muscidae). *J. Econ. Entomol.,* **78:** 19-24.

Harris, C.R., Turnbull, S.A., Whistle Craft, J.W. and **Surgeoner, G.A.** (1982) Multiple resistance shown by field strains of house fly *Musca domestica* L. (Diptera: Muscidae), to organochlorine, organophosphorus, carbamate, and pyrethroid insecticides. *Can Entomol.,* **114:** 447-454.

Harwood, R.F. and **James, M.T.** (1979) *Entomology in Human and Animal Health.* MacMillan Publishing Company, New York, 548 p.

Hinkle, N.L., Sheppard, D.C. and **Nolan, M.P.** (1985) Comparing residue exposure and topical application techniques assessing permethrin resistance in house flies (Diptera: Muscidae) *J. Econ. Entomol,* **78:** 722-724.

Keiding, J. (1976) Development of resistance to pyrethroids in field populations of Danish house flies. *Pesticide Science,* **7:** 283-291.

Keiding, J. (1986) The House Fly-Biology and Control. WHO-VBC-86-973. 63 pp.

Kensler, D.L. Jr. and **Streu, H.T.** (1967) A biological and toxicological study of strains of two-spotted spider mites. *J. Econ. Entomol.* **60:** 1073-1078.

Lieberman, H.K. (1983) Estimating LD_{50} using the probit technique: A BASIC computer program. *Drug and Chemical Toxicology.* **6**(1): 111-116.

Mallis, A. (1969) Handbook of Pest Control. 5th (**ed.**) Mac Nair-Dorland Company, New York, 1158 p.

Motoyama, N., Hayaoko, T., Nomura, K. and **Dauterman, W.C.** (1980) Multiple factors for organophosphorus resistance in the house fly *Musca domestica* L. *Pesticide Science,* **5:** 393-402.

Nazer, I.K. and **Al-Azzeh, T.K.** (1986) Resistance of the house fly *Musca domestica* L. (Diptera: Muscidae) to certain insecticides in the Amman area of Jordan *J. Med. Entomol.,* **23**(4): 405-410.

Respicio, N.C. and **Heitz, J.R.** (1983) Development of resistance to erythrosin B in house fly (Diptera: Muscidae). *J. Econ. Entomol,* **76:** 1005-1008.

Roushi, R.T. and **Wright, J.E.** (1986) Abamectin toxicity to house flies (Diptera: Muscidae), resistance to synthetic organic insecticides. *J. Econ. Entomol.,* **79**(3): 564-566.

Sacca, G. (1973a) Vector control. Assignment Report, Jordan, WHO-EMRO-73-1115, 8 pp.

Sacca, G. (1973b) Vector control. Assignment Report, Jordan, WHO-EMRO-1545, 7 pp.

Sawicki, R.M. and **Holbrook, D.V.** (1961) The rearing, handling and biology of house flies (*Musca domestica* L.) for assay of insecticides by the application of measured drops *Pyr. Post.,* **6**(2): 3-18.

Scott, J.G. and **Georghiou, G.P.** (1985) Rapid development of high level permethrin resistance in a field-collected strain of house fly (Diptera: Muscidae) under laboratory selection. *J. Econ. Entomol.,* **78:** 316-319.

Ward, C.R. and **Tan, F.M.** (1977) Organophosphate resistance in the banks grass mite. *J. Econ. Entomol.,* **70:** 250-252.

World Health Organization (1976) Resistance of Vectors and Reservoirs of Disease to Pesticides. Twenty-second Report of the WHO, Expert Committee on Insecticides, *Tech. Rep. Series,* 585, Geneva, 88 pp.

World Health Organization (1981) Instruction for determining the susceptibility or resistance of flies, tsetse, blow flies, *etc.* to insecticides. WHO-VBC-81, 813, 5 pp.

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استجابة الذبابة المنزلية *Musca domestica* L. (دبترا : مسكيدي) في غور الأردن الأوسط إلى ثمانية مبيدات

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تم جمع الحشرات البالغة للذبابة المنزلية *Musca domestica* L. من محطة البحوث الزراعية في منطقة الغور الأوسط وذلك باستخدام بيئة التغذية التي تربى عليها يرقات هذه الحشرة . بعد ذلك تم نقل هذه الحشرات إلى كلية الزراعة في الجامعة الأردنية لتربيتها . أجريت الفحوصات المخبرية بمعاملة اناث الذبابة المنزلية البالغة والتي تتراوح أعمارها ما بين ٣-٦ أيام بالمبيدات بشكل قمي على صدر الحشرة وذلك وفق توصيات منظمة الصحة العالمية (١٩٨١) .

في هذه التجربة تم تقييم استجابة الذبابة لثمانية مبيدات حشرية واشارت النتائج إلى أن الذبابة المنزلية كانت قادرة على الاحتمال ومتجانسة لمبيد بروبيتامفوس ومبيد فينثيون وكان عامل المقاومة للأثنين (٥٥ ,٣) و (٦١ ,٧) ضعف ، وميل خط الانحدار معادلا لـ (٥٣ ,٢) و (٨٦ ,٢) ، على التوالي .

بالنسبة للمبيدات البيريثرويدية ، اظهرت الذبابة المنزلية قدرة على احتمال المبيدات سايبرميثرن ، بيرميثرن ٢٥ : ٧٥ ، بيرميثرن ٤٠ : ٦٠ وكان عامل المقاومة معادلا لـ (١٩ ,٤) ، (١٤ ,٦) ، و (١٨ ,٨) ضعفا ، على التوالي . ومن جهة اخرى ، اظهرت الذبابة المنزلية مقاومة بسيطة ومتجانسة للمبيدات سايفلوثرين و د-تراميثرن . وكان عامل المقاومة للاثنين (٨٤ ,١٠) ، (١٢ ,٢٨) ضعفا ، على

التوالي وعلاوة على ذلك فان ميل خط الانحدار كان (٤٤ ,١) ، (٤٥ ,١) ، (٤٦ ,١) ، (٥٠ ,١) و(٦٧ ,١) للمبيدات سايبرميثرن ، سايفلوثرن ، بيرميثرن ٤٠ :٦٠ بيرميثرن ٢٥ :٧٥ و د-تراميثرن ، على التوالي .

بالنسبة للمبيد الكاربماتي (بروبوكسر) كان معامل المقاومة معادلا (٢٤ ,١٥) ضعفا وكان ميل الانحدار (٩٤ ,١) ، ويدلنا ذلك على ان الذبابة المنزلية كانت مقاومة بشكل بسيط ومتماثلة في استجابتها لها المبيد .

اظهرت الذبابة المنزلية استجابة متفاوته في قدرة احتمالها ومقاومتها للمبيدات المستخدمة ، وأشارت النتائج إلى أن أفضل استجابة كانت للمبيد بروبيتامفوس ويليه مبيد سايبرميثرن . كما اشارت أيضاً إلى المبيدات التي لها عامل مقاومة اقل من (١٠) اضعاف قادرة على مكافحة هذه الحشرة بصورة مقبولة .