Toxicities Of Several Insecticides To The House Fly *Musca domestica* L. From Different Regions In Jordan

By

Azzam Ahed Saleh

Supervisor

Prof. Husein M. Elmosa

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University of Jordan

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Committee Members	**Signature**
1. Dr. Husein Elmosa, Chairman Prof. of Entomology	....
2. Dr. Abdullah Al-Musa, Member Prof. of Plant Pathology	....
3. Dr. Zuhair Mohsen, Member Prof. of Entomology	....
4. Dr. Mazen Akkawi, Member Assistant Prof. of Entomology	....

Dedication

To My Beloved Home
Land
Palestine

Aknowledgment

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ABSTRACT

Toxicities of Several Insecticides to the House Fly *Musca domestica* L. from Different Regions Locations in Jordan

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Azzam Ahed Saleh

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The LD_{50} of eight insecticides to adult female house flies *Musca domestica* L. were determined by topical application. A syringe-microburet was used to apply the insecticide solution to the mesonota of individual insects. Female flies 3-5 days old were used for testing. Age, sex, loci of application and post treatment temperature were standardized to obtain accurate and repeatable results. Toxicity data are recorded in micrograms toxicant per gram fly.

F1 adult flies tested in this work were the progeny of flies obtained at intervals during the period of Septemper, 1995 to June, 1996 from poultry farms in five different locations in Jordan, namely Amman, Central Jordan Valley (50 km west of Amman), Irbid (90 km north of Amman), Karak (120 km south of Amman) and Al-Dafyaneh (130 Km north east of Amman). For comparison, toxicities of the same insecticides were determined on a laboratory susceptible strain obtained from Denmark.

Results from Amman area indicated that the pyrethroid insecticides tested, i.e., lambda-cyhalothrin, deltamethrin, cypermethrin and cyfluthrin were the most effective insecticides with LD_{50} 1.27, 4.22, 7.08 and 7.37 μgm/gm fly respectively. These relatively small LD_{50}s for the

respective insecticides indicate that the house fly is susceptible to these insecticides. Propoxur and malathion were the least effective with LD_{50} 4230.47 and 3493.30 μgm/gm fly respectively, which shows that the house fly in Amman area has developed resistance to these insecticides. The relatively small slope of log. dose probit lines and the large LD_{50} values for both malathion and propoxur indicate that the house fly in Amman area may develop still greater resistance for both materials.

Cyfluthrin, malathion and propoxur which represent the pyrethroid, organophosphorus and carbamate insecticides respectively, and which proved to be the least effective in Amman area, were tested on flies from four other locations in Jordan. Results revealed that cyfluthrin was much more effective than malathion and propoxur in all locations. Results indicated that flies from the four locations were susceptible to cyfluthrin and were resistant to malathion and propoxur. The relatively small slopes and large LD_{50} show that greater resistance may develop for these insecticides.

SECTION I

INTRODUCTION

I. INTRODUCTION

The common house fly *Musca domestica* L. causes considerable nuisance to people all over the world. Its habit of walking and feeding on garbage and excrement and also on human body and food makes it an ideal agent for the transmission of several infectious diseases such as bacillary dysentry, amoebic dysentry, diarrhea, typhoid, paratyphoid, food poisoning, cholera, helminths, polomyelitis, trachoma, cutaneous diphtheria, yaws and leprosy (service, 1980), (keiding, 1986). The house fly is an important public health pest in Jordan, especially in places where poor sanitary conditions prevail. In Jordan Valley, where intensive farming is widespread, natural fertilizers including sheep cattle and poultry manure were used extensively. This in addition to the favorable weather conditions enhances the development and increases the house fly population to very high levels causing nuisance and diseases to inhabitants and visitors.

Because of its importance as a public health pest, several methods have been employed to control it in different parts of the world including Jordan. Prior to the advent of DDT, and in addition to sanitation, borax, sodium flouride,sodium chloride and pyrethrum extract with kerosene have been used to control the fly. After 1944, with the development of the chlorinated hydrocarbon insecticides, the house fly was satisfactorily controlled with these materials. In mid 1950s the organophosphorus and carbamate insecticides were used for the fly control, followed in 1973 by the synthetic pyrethroid insecticides.

As early as 1946, there were reports by several investigators from different parts of the world that the house fly had developed resistance to the chlorinated hydrocarbon insecticides. This was followed by similar but less widespread development of resistance to other groups of insecticides, namely organophosphorus, canbamates and synthetic pyrethroids (Chapman and Morgan, 1992). In Jordan, several workers reported varying degrees of resistance to various insecticides belonging to the chlorinated hydrocarbon, organophosphorus and carbamate compounds.

As the house fly is the insect species that has shown the greatest ability to develop resistance, it is necessary from time to time, to monitor the resistance of the local flies to the insecticides in use. Taking the preceding points into consideration, the present work started to investigate the toxicities of different insecticides to house flies collected from five different locations in Jordan. The insecticides tested represented the main insecticide groups used to control the insect in Jordan, i.e., ogranophosphorus, carbamates and pyrethroids. It is envisaged that this study will determine the effectiveness of various insecticides used and whether or not resistance develped or apt to develop to these materials. The results of the present study hopefully will be of assistance to authorities concerned to select the most prospective insecticides for successful fly control. These authorities include: Ministry of Health, Ministry of Agriculture, Ministry of Municipalities, Jordan Valley Authority, Greater Amman Municipality, Jordan Environmental Society and Jordan Valley Farmers Associations.

SECTION II

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

1. Relative Toxicities of Different Insecticides to the House Fly

Since the first report that house flies in northern Sweden did not respond as expected to DDT in 1946 (Brown, 1971), several hundred of similar instances have been noted involving many of the newer insecticides, starting with resistance to BHC and dieldrin which was first reported in 1948 (Busvine, 1963). King (1950) working in two localities of Florida found that DDT-resistant flies can be effectively controlled by using lindane at 50 mg per square foot. Two years later, Goodwin and Schwardt (1953) reported that flies have developed resistance to lindane and all other insecticides used as residual sprays in dairy barns of New York state .

Resistance to the newly introduced organophosphorus insecticides was first noticed in Denmark and USA in 1955, and later in many other countries (Brown and Pal, 1971), (Pal and Wharton, 1974). In California, Georghiou and Bowen (1966) reported that the highest degrees of resistance detected by topical application of some organophosphorus and carbamate compounds were; malathion > 70x, diazinon 25x, ronnel 14x, fenthion 10.1x, dimethoate 4.2x, dimetilan 3.7x and mercules 3.5x. The last authors also they found a high level of resistance to DDT despite more than 10 years of nonuse, they explained that the prolonged stability of DDT resistance was likely enhanced by diazinon pressure. Hansens et al. (1967) studied the development of resistance in two counties of New Jersey using 0.5 and 1.0% residual treatments with diazinon, Ronnel, and dimethoate for 4 years. Results have shown that longest control and highest resistance were obtained where 1% insecticide was used. In addition to that, they reported that resistance increases in the summer, depending on sanitation, weather conditions and insecticide use, and decreases somewhat in winter months, where the levels of resistance are measured in the fly population as a whole . Keiding (1965) showed that at the end of one season of use, malathion resistance appeared as a highly resistant small sector of flies. By the 3rd or 4th season such flies became established as an important part of the population.

In Denmark, Keiding (1976, 1977) reported that topical application tests in 1971-1973 with flies from many farms showed moderate to high multiresistance to organophosphorus compounds, the ranges of resistance ratios R/S at LD_{95} level were: dimethoate 19-394x, fenitrothion 7-53x, fenthion 9-48x, jodphenphos7-28x. In addition there was a general high heterogeneous resistance to malathion, tetrachlorvinphos and trichlorfon. Also, high, often heterogeneous resistance for both chlorinated hydrocarbons and carbamates was found. Moreover, he found that the high organophosphate-resistance did not involve pyrethroids unless field pressure with pyrethroids was applied. During the same period, in farms treated frequently with pyrethroid aerosols containing pyrethrum /piperonyl butoxide, the maximum resistance ratios R/S were: pyrethrum /piperonyl butoxide (1:5), 40x bioresmethrin/piperonyl butoxide (1:5), 55x bioresmethrin, 191x tetramethrin/piperonyl butoxide (1:5), 171x tetramethrin/ resmethrin (1:5), 78x.

Rupes et al. (1980), studied the insecticide resistance in 83 wild house fly populations from a number of farms in Czechoslovakia for a period of four years. Resistance was very high to trichlorfon, and considerable to fenitrothion and the carbamates dioxicarb, propoxur and bendiocarb. DDT resistance was found to be mostly very high. On the other hand, no significant resistance to the pyrethroids tetramethrin, permethrin and deltamethrin was found.

Chapman and Morgan (1984), assessed the resistance levels of house flies obtained from 34 farms in the United Kingdom. Ranges of the topically–determined resistance ratios were: methomyl 1.1-15.9x, azamethiphos 2.2-36.9x pyrethrins + piperonyl butoxide 0.9-6.8x and permethrin 1.7-34.8x

Tsunoda et al. (1994) studied the susceptibility of house flies collected from six places in Nepal to eight insecticides by the topical application method. Results revealed that some colonies showed no susceptibility to DDVP, fenitrothion and propetamphos, while, the pyrethoids d-t,allethrin and permethrin showed small LD_{50} for all colonies.

The global status of house fly resistance to different insecticides has been summerized by WHO (1992) as follows:
DDT: generally wide spread resistance.
Organophosphorus insecticides: Resistance to malathion and one or more organophosphorus compounds is generally widespread, and broad-spectrum resistance is common in Europe, Asia, and the Americas. Besides malathion, high resistance commonly involves fenitrothion, jodfenphos, bromophos, trichlorfon, diazinon, and often coumaphos and tetrachlorvinphos, while moderate to low resistance to several other organophosphorus compounds has been found in many areas.
Carbamates: resistance to one or more carbamate insecticide is wide spread.
Pyrethroids: only a few cases of resistance have been found in Canada, Czechoslovakia, Finland, Japan, Netherlands, Norway, Poland, and the USA, and several cases have been found in Australia, Denmark, France, Germany, Sweden, Switzerland, and the United Kingdom. Tests on many

fly populations in other parts of the world have shown susceptibility to pyrethroids.

In Jordan, Sacca (1973) using the topical application method investigated the toxicity of several insecticides to the house fly collected from Amman area. He reported high resistance to DDT and incipience of resistance to lindane, bromophos, fenthion and malathion. He also reported negligible resistance to pirimiphosmethyl and propoxur while there was no resistance to tetrachlorvinphos. Brooke and Martin (1975) followed the topical application method on flies from Amman area and reported varying degrees of resistance to bioresmethrin 2.62x, bromophos-methyl 85.7x, Baytex 26.6x, Baygon 25.8x, dimethoate 26.4x, pirimiphos methyl 17.9x and DDT 360x. Al-Azzeh (1984) evaluated the toxicities of several insecticides by the topical application method to adult female house flies collected from two locations in Amman, namley Royal Horse Racing Club and a dairy barn in Sweileh. He found that the house flies have developed resistance to the chlorinated hydrocarbon insecticides (DDT, dieldrin, and lindane); and to the organophosphorus compounds (dimethoate, diazinon, and dichlorvos). Meanwhile the house fly was found to be tolerant to the pyrethroid insecticides (deltamethrin and permethrin). However the pyrethroid insecticide d-phenothrin proved to be the most effective of the tested insecticides in both locations. Abu-Nada (1990) working on house flies from the Central Jordan Valley concluded that propetamphos and cypermethrin were more effective against the house fly than the other six insecticides tested. The topically-determined LD_{50} (microgram toxicant per fly) and resistance ratios were: cypermethrin, (0.129, 4.19x), permethrin 25: 75, (0.183, 6.14x); permethrin 40:60, (0.196, 8.18x); cyfluthrin, (0.202, 10.84x); propetamphos, (0.279, 3.55x); fenthion, (0.349, 7.61x); d-tetramethrin (1.068, 28.12x) and propoxur (6.52, 15.24x).

SECTION III

MATERIALS AND METHODS

III. MATERIALS AND METHODS

1. Method of Obtaining House Flies

1.1. Field-Collected House Fly Adults

The flies used in this research were obtained at intervals during the period of September, 1995 to June, 1996, from poultry farms in five different locations in the country (Fig. 1). These locations are : Irbid (90 km north of Amman), Karak (120 km south of Amman), Al-Dafyaneh (130 km north east of Amman), The university experiment station in Central Jordan Valley (50 km west of Amman) and the university of Jordan in Amman. Flies collected from different locations will be referred to hereafter as Irbid strain, Karak strain, Al-Defyaneh strain, Central Jordan Valley strain and Amman strain.

Collection was made by the use of one liter jar containing approximatly 10 ml of fruit jam. The jar was placed in a poultry farm, and after few flies were attracted, the jar was closed with cheese cloth and transferred to a rearing cage which will be described later. Collection was repeated several times until approximately 200 flies were obtained. Flies collected were then taken to the laboratory for rearing to obtain F1 generation which was used for testing.

House flies were reared at room temperature in a room at the college of agriculture, university of Jordan. Cages 40 cm long, 40 cm wide and 40 cm high were used for rearing the house fly. The cages were covered with 16 mesh screen with cloth sleeve opening at the front.

Adult house flies were fed on a diet composed of two parts of defatted powdered milk and one part of sugar. Water was supplied by a cotton pad placed on the surface of 100 ml glass beaker filled with water. The cotton pad was held on the surface by the use of a piece of polystrene.

A petri dish containing a piece of cotton immersed in 5% solution of the

Figure 1. Locations in Jordan from which house flies were collected.

adult flies diet described above was placed inside each cage. After approximately twenty hours of placing the petri dishes containing the oviposition medium, eggs were collected simultaneously and placed on the surface of the larval diet which consisted of 100 gm of wheat bran, 50 gm of chicken broiler diet, and 150 ml water placed in two liter glass beaker. About 500 eggs were cultured in each beaker. The beakers were then covered with muslin cloth. Two days after egg hatching, a 5 cm thick layer of sand was added on top of the medium to form a cooler and drier place for the larvae to pupate (Sumitomo, 1977). Pupae were collected by using a 25 mesh-sieve, and hundred pupae were transferred to each two liter-glass beaker for fly emergence.

Adult flies were supplied with food consisting of honey and water placed on a cotton pad held on top of the muslin cloth covering the beaker. Rearing took place in a temperature controlled cabinet at 22-27 °C and a constant illumination of 12:12 LD (Kence and Kence, 1993), (Saito et al., 1991).

1.2. Laboratory Strain of House Fly Adults

These house flies were reared from a culture of flies obtained courtesy of Mr. Jorgen Jespersen, Danish Pest Infestation Laboratory, Lyngby, Denmark. As far as known this culture of flies had had no previous contact with insecticides. The flies since March, 1996 have been reared in the laboratory at the university of Jordan by the previously described method.

2. Insecticides

Eight insecticides representing organophosphorus, carbamate and pyrethroid groups were tested. The insecticides used, their purity, and the sources from which they were obtained are listed in table 1. The names used here are those listed in the Pesticide Manual published by the Birtish Crop Protection Council (1987).

Table 1. Insecticides used, their purity and the sources from which they were obtained.

Insecticide* (common name)	Percent Purity	Source
Malathion	96	Cheminova Agro. A/S, DK.
Fenitrothion	95.5	Cheminova Agro. A/S, DK.
Chlorpyrifos	99.8	Riedel-de Haen AG., Germany.
Propoxur	98	Bayer, Germany.
Cypermethrin	90	Riedel-de Haen AG., Germany.
Cyfluthrin	94.5	Bayer, Germany.
Deltamethrin	98	Riedel-de Haen AG., Germany.
Lambda-cyhalothrin	98	Zeneca, U.K.

* All insecticides were obtained from the Pesticides Toxicity and Formulation Center, Ministry of Agriculture except lambda-cyhalothrin which was obtained from Dr. Zohir Muhsen, Arab Pest Control Center.

3. Topical Application of Insecticides

In topical application of insecticides to individual insects, accuracy and ease of operation are most important. Topical application is usually accomplished by treating individual insects with small volumes of insecticide solutions. Trevan (1922) suggested that small droplets of fluid could be produced by using the pitched thread of a machinist's micrometer to drive the plunger of a small syringe. After Trevan developed the micrometer-syringe, topical application was widely employed in insect toxicology, and most of the topical application apparatus in use today embodies Trevan’s principle (Metcalf, 1958).

The apparatus used for topical application in this research was a modified syringe-microburet, (Elmosa, 1959) made by the Micro-Metric Instrument Co. of Cleveland, Ohio. The syringe-microburet (Fig. 2) employs

Figure 2. The syringe-microburet by which the toxicant was topically applied to the insect.

a thumbscrew-operated shaft which advances the stem of the direct dial micrometer guage. This stem which is carried through the guage, advances the plunger of the syringe and delivers the insecticide solution through the syringe. The syringe used in the work reported here is made by Hamitton Co. Reno. Ne., U.S.A and divided into 50 divisions with each division measuring one microtliter of solution.

A day before testing, female flies 3-5 days old (WHO, 1981) were sorted out after anesthetization with carbon dioxide, and were left overnight in an incubator at 25±1C°. The insects were supplied with food consisting of honey and water as previously described.

Arbitrary preliminary dosages were tested in order to determine the lethal dosages tested in this study. Individual insects were treated with the respective insecticides solutions after they had been anesthetized with carbon dioxide. The carbon dioxide was obtained as a liquified gas in cylinders under pressure. The gas was allowed to escape through a pressure reducing valve at a slow rate through a 15 cm Buchner funnel in which the test insects were confined. The modified syringe-microburet was used to apply the insecticide solution to the mesonota of individual insects. The toxicant was dissolved in acetone and one microliter of solution was applied to each fly. At least five dose levels of each insecticide were used to determine the LD_{50}. Four replicates of ten flies each were used at each dose level. A control treament of 10 flies was also run with each replicate. Control flies recieved one microliter of acetone only. After treatment, flies were confined in a 150ml plastic containers covered with cheese cloth held in place by a rubber band to prevent the escape of the treated flies and transferred to an incubator at 25 ± 1 °C. Honey and water were supplied to the treated insects on a piece of cotton placed on top of the cheese cloth. Mortality counts were made 24 hours after treatment. The criterion for mortality was the inability of the insect to show active locomotion. The individual weights of fifty 3-5 day old female flies were weighed to determine the average weights of a female house fly from each location in addition to the susceptible strain. The weights are recorded in appendix 2.

4. Data Analysis

Data were analysed by a computer program based on the method of Finney (1952). The program was modified and adapted to Apple II computer by Lieberman (1983), then it was readapted to IBM computer. The calculated results include: LD50 and its confidence intervals, the slope and the intercept of the regression line.

Significance between LD50 for the different insecticides in different locations was based on non overlap of confidence intervals (Scott and Rutz, 1988).

Average weights of female flies from the different locations in addtion to that from the laboratory susceptible strain were statistically compared by the use of the Statistical Analysis System (SAS) software based on Duncan's multiple range test to find out whether or not significant differences between these weights are present.

5. Resistance Ratio

The resistance ratio (R/S) is used to illustrate the degree of resistance or susceptibility of a field-collected strain compared to a laboratory susceptible strain. R/S at LD50 can be calculated by dividing the LD50 for a field strain by the LD50 for the susceptible strain. (Keiding, 1976,1977).

SECTION IV

RESULTS & DISCUSSION

IV. RESULTS & DISCUSSION

1. The Respective Toxicities of Eight Insecicides to Amman Strain of House Fly Adults.

The LD_{50} in microgram of toxicant per gram of fly (μgm/gm fly), 95% confidence limits, the slopes of the log. dose probit lines and the resistance ratios (R/S) for the insecticides tested on flies collected from five different locations in Jordan i.e, Amman, Central Jordan Valley, Irbid, Karak, and Al-Dafyaneh in addition to flies of a laboratory susceptible strain are presented in tables 2-8 and figures 3-8.

The LD_{50} for flies collected from Amman area, as shown in table 2, indicate high degree of variability between the eight insecticides tested. The table shows that the pyrethroid insecticides tested, i.e, lambda-cyhalothrin, deltamethrin, cypermethrin and cyfluthrin in addition to the organophosphorus compound chlorpyrifos were the most effective insecticides with LD_{50} 1,27, 4.22, 7.08, 7.37 and 10.69 μgm/gm fly respectively. Propoxur and malathion were the least effective with LD_{50} 4230.47 and 3493.30 μgm/gm respectively.

In a review of arthorpod resistance to chemicals, Hoskins and Gordon (1956) stated that the LD_{50} is an index of the mean tolerance or the mean resistance of the insects tested. The LD_{50}, if obtained with wild unexposed insects gives the tolerance of the species, or if obtained with individuals from an area treated with an insecticide it gives a measure of the resistance that has been developed. Determination of the LD_{50} from time to time will show how the average resistance varies and how it is affected by any control procedure, such as continued use of insecticide substitution of another, or use of none at all. Therefore the LD_{50} is a measure of what already happened and gives little indication of what may be expected. For the latter purpose the log. dose probit line is much more informative.

The slope of the log. dose probit line is a measure of the diversity of response or the heterogeniety of the insects toward the toxicant used. In the normal susceptible condition of insects, the slope is great, when resistance begins to develop the slope decreases. This decrease in slope will continue untill resistance tends to reach a plateau (Hoskins and Gordon, 1956), and subsequently the slope increases. This phenomenon seems to be true with the slopes recorded for the insecticides tested. Table 2 shows very large LD_{50} and relatively small slope for propoxur and malathion (Fig. 3) which indicates that the flies are resistant to the two insecticides, and resistance did not reach its limit. It is expected that the house fly will develop still greater resistance to propoxur and malathion. Table 2 also shows low LD_{50} and relatively small slopes for lambda-cyhalothrin, deltamethrin, cypermethrin, cyfluthrin and chlorpyrfos (Fig. 3). One may speculate that there is certain degree of heterogeniety and resistance is apt to develop.

According to Hoskins and Gordon (1956), resistance is recognizable with certainity when its effect is marked, especially if this can be expressed numerically. Therefore, it has become standard practice to make laboratory comparisons of flies from the suspected resistant population with others from an untreated area or from a laboratory susceptible strain. Toxicities of the same insecticides tested on flies from Amman were also determined for a susceptible strain of fly obtained from Denmark and results are presented in table 3. The table indicates that the LD_{50} values of all insecticides tested were significantly smaller than those obtained with flies from Amman and other locations. This coupled with the fact that the slope of the log. dose probit lines for the susceptible strain, as shown in table 3 and figure 4, are larger than those obained with the field-collected flies prove that the flies from Amman and other locations probably show certain degree of heterogeniety toward all insecticides tested. In addition resistance ratios for field collected flies were calculated according to Keiding (1976) by dividing the LD_{50} of the suspected resistant flies on the LD_{50} of the susceptible strain, and results are presented in table (2). The resistance ratios for flies collected from Amman were : Cypermethrin (1.96 x), lambda-cyhalothrin 4.76x, deltamethrin 4.82x, cyfluthrin 4.98x, chlorpyrifos 8.48x fenitrothion 28.92 x, propoxure 159.82x and malathion 301.15x.

According to Kensler and Streu (1967) and Keiding (1976), a ten fold or greater increase in the LD_{50} compared with a susceptible strain means that the tested population have various degrees of resistance, whereas levels less than ten fold were considered increased tolerance. Accordingly, the fly population from Amman area showed various degrees of susceptibility toward lambda-cyhalothrin, deltamethrin, cyfluthrin, cypermethrin, and chlorpyrifos, while it appeared to be resistant to fenitrothion and, to greater extent, to malathion and propoxur.

Table 2. Toxicities of eight insecticides as determined by topical application to house flies collected from the university of Jordan, Amman.

Insecticide	LD_{50}* Micrograms/Gm Fly	95% Confidence Limits	Slope of Log. Dose Probit Line (±SE)	Resistance Ratio at LD_{50} (R/S)
Lambda-cyhalothrin	1.27 c	1.04-1.51	2.67±0.33	4.70
Deltamethrin	4.22 e	3.23-5.21	2.39±0.31	4.82
Cypermethrin	7.08 fg	5.08-8.82	2.36±0.38	1.96
Cyfluthrin	7.37 fg	5.21-9.30	2.16±0.35	4.98

Chlorpyrifos	10.69 g	8.49-12.86	2.52±0.40	8.48
Fenitrothion	52.35 i	42.57-61.92	2.65±0.39	28.92
Malathion	3493.30 mn	2809.97-4412.11	2.07±0.29	301.15
Propoxur	4230.47 n	3163.30-5689.16	1.39±0.25	159.82

* Values in the same column followed by the same letter are not signficantly different at 95% confidence level.

Figure 3. Log. dose probit lines of the insecticides tested on Amman strain

Table 3. Toxicities of eight insecticides as determined by topical application to a laboratory susceptible strain of house fly adults.

Insecticide	LD_{50} * Micrograms/Gm. Fly	95% Confidence Limits	Slope of Log. Dose Probit Line (±SE)
Lambda-cyhalothrin	0.27 a	0.22-0.32	2.76±0.33
Deltamethrin	0.88 b	0.73-1.03	3.00±0.36
Chlorpyrifos	1.26 c	1.07-1.47	3.12±0.32
Cyfluthrin	1.48 cd	1.30-1.70	3.45±0.48
Fenitrothion	1.81 d	1.54-2.10	3.67±0.15
Cypermethrin	3.61 e	3.01-4.27	2.90±0.40
Malathion	11.60 g	9.86-13.37	3.20±0.42
Propoxure	26.47 h	23.56-29.38	4.76±0.58

* Values in the same column followed by the same letter are not signficantly different at 95% confidence level.

Figure 4. Log. dose probit lines of the insecticides tested on a laboratory susceptible stra

2. The Respective Toxicities of Cyfluthrn, Malathion and Propoxur to Different House Fly Strains Collected in Jordan

Cyfluthrin, malathion and propoxur representing pyrethroid, organophosphorus and carbamate groups respectively and proved to be the least effective against Amman strain were tested on flies from Central Jordan Valley, Irbid, Karak and Al-Dafyaneh. Insecticides were applied to these flies by the same method described previously. The LD_{50} and slopes of the log. dose probit lines were determined and compared with the laboratory susceptible strain.

2.1 Toxicities of Cyfluthrin, Malathion and Propoxur to Central Jordan Valley Strain of House Fly Adults.

The insecticides, cyfluthrin, malathion and propoxur which proved to be the least effective against the house fly from Amman area were tested against flies from Central Jordan Valley to find out their respective toxicities and whether or not this strain of flies is resistant to these insecticides. The LD50 and slope of the log. dose probit lines for the three insecticides were determined (Table 4 and Fig. 5) and compared with that of the susceptible strain (Table 3 and Fig. 4). Cyfluthrin was found to be much more effective than both malathion and propoxur. The LD_{50} for cyfluthrin, malathion and propoxur were 5.84, 2763.92 and 4471.17 μ gm/gm fly respectively.

The LD50 of cyfluthrin to the susceptible strain was 1.48 and to the Central Jordan Valley strain was 5.84. Although the LD50 of the latter is larger than the LD50 for the former, the flies are considered to be susceptible to this insecticide. This will be more evident if the relatively large slope of the log. dose probit line is taken into consideration.

The LD_{50} for both malathion and propoxur were 2763.92 and 4471.17 µgm/gm fly respectively, which indicates strongly that the Central Jordan Valley strain is resistant to these insecticides. The relatively small slopes for both insecticides (Fig. 5) reveal that resistance did not reach its plateau and it is expected that greater resistance to malathion and propoxur will develop.

Table 4. Toxicities of cyfluthrin, malathion and propoxur to the Central Jordan Valley Strain of House Fly Adults.

Insecticide	LD_{50}* Micrograms/Gm fly	95% Confidence limits	Slope of log. Dose probit line (±SE)	Resistance Ratio at LD_{50} (R/S)
Cyfluthrin	5.84 ef	4.23-7.21	2.87±0.45	3.95
Malathion	2673.92 Lm	2182.56-3478.56	1.97±0.26	238.27
Propoxur	4471.17n	3128.02-6583.51	1.16±0.26	168.91

* Values in the same column followed by the same letter are not signficantly different at 95% confidence level.

Figure 5. Log. dose probit lines of cyfluthrin, malathion and propoxur to Central Jordan V

2.2 Toxicities of Cyfluthrin, Malathion and Propoxur to Irbid Strain of House Fly Adults.

House flies from Irbid were tested to find out whether or not resistance developed to cyfluthrin, malathion and propoxur. The LD50 and the slope of the log. dose probit lines for these three insecticides are presented in table 5 and figure 6. The table shows that cyfluthrin was much more effective than both malathion and propoxur. the LD50 were 6.39, 2574.24 and 4104.47 μgm/gm fly for the three insecticides respectively. The small LD50 and relatively large slope for cyfluthrin (Table 5 and Fig. 6) indicate that the flies from Irbid are susceptible to this chemical.

Table 5 also shows very large LD50 for both malathion and propoxur which indicates strongly that the house fly from this locality is resistant to both insecticides. The LD_{50} for malathion and propxure against Irbid strain were 2574.24 and 4104.47 and against the susceptible strain were 11.6 and 26.47 μgm/gm fly respectively. The relatively small slopes (Fig. 6) for both insecticides indicate that resistance did not reach its plateau and higher levels of resistance to malathion and propoxur may develop.

Tabe 5. Toxicities of cyfluthrin, malathion and propoxur to Irbid strain of house fly adults.

Insecticide	LD_{50}^{*} Micrograms/Gm fly	95% Confidence limits	Slope of log. Dose probit line (±SE)	Resistance ratio at LD_{50} (R/S)
Cyfluthrin	6.39 f	5.26-7.59	2.78±0.339	4.32
Malathion	2574.24 klm	1959.47-3470.44	1.25±0.164	221.92
Propoxur	4104.47 mn	3151.56-5568.34	1.33±0.162	155.06

* Values in the same column followed by the same letter are not signficantly different at 95% confidence level.

Figure 6. Log. dose probit lines of cyfluthrin, malathion and propoxur to Irbid st

2.3 Toxicities of Cyfluthrin, Malathion and Propoxur to Karak Strain of House Fly Adults

The toxicities of cyfluthrin, malathion and propoxur were tested against house flies collected from Karak to ascertain whether or not house flies from this part of the country are resistant to these insecticides. Resutls are shown in table 6. The LD_{50}s for cyfluthrin, malathion and propoxur were 4.20, 1637.06 and 3329.49 μgm/gm fly respectively. The small LD_{50} for cyfluthrin compared with the large LD_{50} for malathion and propoxur indicates strongly that cyfluthrin is the most effective and the flies are susceptible to it.

Since the LD_{50} for malathion and propoxur are large and the slope of the log. dose probit lines are relatively small (Fig. 7), the insect is considered to be resistant to both insecticides and resistance did not reach its plateau. The LD_{50} for malathion was 1637.06 fly and for propoxur was 3329.49 μgm/gm fly.

Table 6. Toxicities of cyfluthrin, malathion and propoxur to Karak strain of house fly adults.

Insecticide	LD_{50}^{*} Micrograms/Gm fly	95% Condidence limits	Slope of log. Dose probit line (±SE)	Resistance Ratio at LD_{50} (R/S)
Cyfluthrin	4.20 e	3.44-4.90	3.39±0.47	2.84
Malathion	1637.06K	1280.48-1998.33	2.12±0.26	141.13
Propoxu	3329.49 mn	2626.26-	1.59±0.20	125.78

r		4402.51		

* Values in the same column followed by the same letter are not signficantly different at 95% confidence level.

Figure 7. Log. dose probit lines of cyfluthrin, malathion and propoxur tested on Kar

2.4. Toxicities of Cyfluthrin, Malathion and Propoxur to Al-Dafyaneh Strain of House Fly Adults.

To find out if flies collected from the eastern part of the country are resistant to cyfluthrin, malathion and propoxur, the LD_{50} and slope of the log. dose probit lines were obtained with the same method mentioned previously. Results are shown in table 7. The table shows that cyfluthrin was much more effective than both malathion and propoxur. The LD50 (μ gm/gm fly) for cyfluthrin, malathion and propoxur were 4.16, 1052.90 and 1942.10 respectively. The small LD_{50} in addition to the relatively large slope for cyfluthrin (Table 7) indicates that Al-Dafyaneh strain is susceptible to this insecticide.

The LD_{50} for malathion and propoxur to Al-Dafyaneh strain were 1052.9 and 1942.10 μgm/gm fly respectively. These large LD50 indicate that the flies are resistant to both insecticides. The relatively small slopes of log. dose probit lines (Fig. 8) for the two insectcides reveals that resistance did not reach its plateau and further increase in resistance may occur.

Table 7. Toxicities of cyfluthrin malathion and propoxur to Al-Dafyaneth strain of house fly adults.

Insecticide	LD_{50}* Micrograms/Gm Fly	95% Confidence Limits	Slope of log. Dose Probit Line (±SE)	Resistance Ratio at LD_{50} (R/S)
Cyfluthrin	4.16 e	3.46-4.95	2.97±0.34	2.81
Malathion	1052.90 j	846.03-1229.33	2.13±0.23	90.76

Propoxur	1942.10 kl	1554.45-2429.53	1.78±0.19	73.37

* Values in the same column followed by the same letter are not signficantly different at 95% confidence level.

Figure 8. Log. dose probit lines of cyfluthrin, malathion and propoxur tested on Al-Daf

Table 8. LD_{50} and slope of log. dose probit lines for cyfluthrin, malathion and propoxur tested on flies from five locations in Jordan in addtion to a susceptible strain of house fly adults.

Location	Insecticide					
	Cyfluthrin		Malathion		Propoxur	
	LD_{50}	Slope	LD_{50}	Slope	LD_{50}	Slope
Amman	7.32 fg	2.16	3493.30 mm	2.07	4230.47 n	1.39
Gentral Jordan Valley	5.84 ef	2.87	2763.92 lm	1.97	4471.17 n	1.16
Irbid	6.39 ef	2.78	2574.24 klm	1.25	4104.47 mn	1.33
Karak	4.20 e	3.39	1637.06 k	2.12	3329.47 mn	1.59
Al-Dafyaneh	4.16 e	2.97	1052.90 j	2.13	1942.10 kl	1.78
Susceptible Strain	1.48 cd	3.45	11.60 g	3.2	26.47 h	4.76

* Values followed by the same letter are not signficantly different at 95% confidence level.

In the present study the LD_{50}s of a number of insecticides for house flies obtained from different locations in Jordan in addition to a susceptible strain of flies were determined by topical application. Age, sex, loci of application and post-treatment temperature were standardized as described previously. In toxicological investigations it is of importance to be able to obtain consistent results. Research on insecticides involves two components, the insect and the insecticides; and in order to obtain repeatable results both of them must be standardized. It is well known that in a given species of insects, large variation in susceptibility may occur. Busvine (1957) listed the sources of variability in insects under two headings, intrinsic differences and extrinsic differences. Under intrinsic factors which affect the susceptibility of insects to insecticides he listed sex, age and the stage of development. Under extrinsic factors temperature and relative humidity were listed.

In measuring the relative toxicity of a number of insecticides to a particular pest, it is important to test such insecticides under field conditions where they will ultimately be used. This was recognized by Busvine (1957) when he wrote "Logically of course, the best criterion is a full scale field trial, but such trials are expensive, slow and owing to the difficulty of providing adequate replications to make up for great variability, do not always produce unambiguous conclusions. Therefore they should be reserved till laboratory tests have narrowed the choice down to two or three substances".

Laboratory tests to evaluate a number of insecticides against the house fly were carried out in 1995-1996 in Jordan. Table 2 indicates that the pyrethroid insecticide were much more effective against the house fly than the organophosphorus and the carbamate compounds. Table 2 also indicates strongly that the insect was resistant to malathion and propoxur and was moderately resistant to fenitrothion.

Increased resistance in an insect population is first suspected if the failure of a standard treatment to give control equal to that obtained previously or large LD_{50} is obtained for the insecticide involved. This however, is not a positive proof that the insect is actually resistant to a certain insecticide. In order to ascertain if a particular insect is resistant to a certain insecticide, laboratory tests are usually carried out to give a direct comparison between a known normal strain and the one under suspicion. To confirm if the house fly was resistant to malathion, propoxur and cyfluthrin samples of the suspected resistant flies from 5 locations in Jordan and samples of susceptible flies were tested in the laboratory, and the LD_{50} for the six populations was established.

Table eight shows that the LD_{50} for malathion and propoxur to the house fly adults obtained from Denmark were 11.6 and 26.47 μgm/gm fly, respectively. The LD_{50} of flies obtained from Amman, Central Jordan Valley, Irbid, Karak and Al-Dafyaneh for malathion were 3493.3, 2763.9, 2574.2, 1637 and 1052.9 and for propoxur were 4230.5, 4471.2, 4104.5, 3329.5 and 1942.1 μgm/gm fly, respectively. This confirmed that the sample of house flies obtained from different locations in Jordan were positively resistant to malathion and propoxur.

The resistance for malathion and propoxur in the different locations may be attributed to selection pressure and cross resistant extending from other insecticides. Saito *et. al* (1991) found that selection of azamethiphos-resistant flies resulted in high resistance to several insecticides including malathion, fenitrothion and propoxur, while there was no resistance to pyrethroids. Also several workers have reported that selection pressure with pyrethroid insecticides enhance the development of resistance to organophosphorus compounds (Goldena and Forgash, 1985), (Scott and Georghiou, 1985), (Funaki and Motoyama, 1986). Moreover, the use of other organophosphorus and carbamate insecticides in agriculture may enhance the development of resistance to public health compounds (WHO, 1976, 1992). It is to be mentioned that more than 600 tons of public health related insecticides have been imported to the country during the period 1980-1994 (Ministry of Agriculture, 1994). It is also important to note that the use of aerosols to control house flies indoors is widespread in Jordan which may enhance the development of resistance.

Sacca (1973) working on flies from Amman area found various levels of resistance to several insecticides including propoxur to which flies showed susceptibility with R/S 2.8x. Later, Brook and Martin (1975) found that flies from Amman were resistant to propoxur with R/S 25.8x, while the experimental evidence in this research revealed that flies from the same area were resistant to propoxur with R/S 159.8x. Also, Abu-Nada (1990) reported that flies from Central Jordan Valley were moderately resistant to propoxur (15.24x). In the present work, R/S for flies from the same location was 168.9x. This indicate that flies in Jordan Valley developed much greater resistance to porpoxur after 1990.

The house flies tested in all locations showed susceptibility to cyfluthrin with significantly smaller LD_{50} for both Karak and Al-Dafyaneh strains. This may be due to the relatively less use of insecticides and consequently less selection pressure in both Karak and Al-Dafyaneh vis-a-vis other locations. Furthermore, Amman strain showed susceptibility to all pyrethroids tested with R/S ranging from 2.0-5.0x.

Keiding (1986) reported that high resistance to pyrethroids was only found locally in Denamrk, Sweden, Germany, Switzerland and the United Kingdom in populations exposed to frequent treatments of aerosols or residual sprays with pyrethroid insecticides. In most of these places the knock down resistance (kdr) gene, which is the gene that is involved in the mechanism of insecticide resistance by reducing the sensitivity of the nervous system to that insecticide and its analogues, forms an important component of pyrethroid resistance, and it is strongly recommended to monitor for kdr before considering using residual pyrethroids for fly control. He added that kdr gene seems to be rare in most parts of the world outside northern and central Europe, and pyrethroids may be very effective in such areas. This seems to be true since the present work revealed that all fly strains tested from Jordan are susceptible to these insecticides despite over twenty years of continued use (Ministry of Health, 1981). This coincides with the results obtained by various workers in Jordan who reported that house flies were susceptible to the pyrethroid insecticides tested.

As discussed above, several workers in Jordan have found various levels of resistance to many insecticides tested. In addition, the present work revealed that house flies from the five regions investigated showed various levels of resistance to cyfluthrin, malathion and propoxur. Taking into consideration the fact that a certain resistance factor may work against different insecticides, the possibilities of chemical control of a particular population becomes less with each resistance the population acquires. Therefore, successive application of different insecticides to prevent or delay development of resistance seems to be only of limited value. True changes in the direction of house fly control seems only feasible when nonchemical methods are regularly combined with conventional insecticides (Rupes *et. al*, 1982), (Keiding, 1986).

Conclusions and Recommendations

Conclusions:

Laboratory tests by topical application of different insecticides to the house fly collected from five different locations in Jordan, in addition to a laboratory susceptible strain revealed the following :

1. The most effective insecticides against the house fly from Amman area was lambda-cyhalothrin followed by deltamethrin, cypermethrin and cyfluthrin, and least effective were malathion and propoxur.
2. Cyfluthrin was much more effective against house flies from the different locations than both malathion and propoxur.
3. Toxicities of various insecticides in different locations in Jordan indicated that the insect is resistant to most of the organophosphorus insecticides tested and also to propoxur which represent the carbamate compounds.
4. The house fly from different locations in Jordan was susceptible to all pyrethroid insecticides tested.
5. The smaller LD_{50} for the insecticides assessed against flies in Karak and Al-Dafyaneh, namely, cyfluthrin, malathion and propoxur, compared to other locations, may be attributed to less intensive use of insecticides in the two locations.

Recommendations:

1. Since the house fly in Jordan showed varying degrees of resistance to most organophosphorus and carbamate insecticides tested, it is recommended to take this into consideration in selecting compounds to be used in controlling house flies.

2. Since the insect was found to be susceptible to the pyrethroid insecticides, it is recommended to try these materials for house fly control.
3. As it is of utmost importance to monitor insecticides performance from time to time, it is recommended to carry out laboratory investigations on this line in the near future.
4. According to the assumption reported in the literature that the kdr gene may not be present in Jordan, it may be worthwhile to investigate this point.

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APPENDICES

APPENDIX 1:

The Mathematical Procedure in Determining the LD_{50} for Lambda-Cyhalothrin by a Computerized Probit Analysis Method.

NAME OF TEST : Lambda- cyhalothrin tested on Amman strain.

NO. OF DOSES : 5

PERCENT OF CONTROL RESPONDING: 0.00

DOSE NO.	DOSE	NO. OF INSECTS TESTED	NO. OF INSECTS RESPONDING
1	4	40	37
2	3	40	33
3	2	40	28
4	1	40	15
5	0.5	40	6

PROBIT ANALYSIS FOR LAMBDA-CYHALOTHRIN ON AMMAN STRAIN.

SLOPE = 2.67 INTERCEPT = 4.72

VARIANCE SLOPE = 0.11

CHI 2 = 0.28 DF = 4

LOG. ED50 = 0.104

95% CONFIDENCE INTERVAL = 0.18 – 0.018

VARIANCE LOG. ED50 = 1.6 E $^{-}$03

ED50 = 1.27

95% CONFIDENCE INTERVAL = 1.50 – 1.04

Y = 2.67 X +4.72.

APPENDIX 2:

The Individual Weights in Milligrams of Adult House Flies Obtained from Different Locations in Jordan and House Flies from Denmark.

Amman	Jordan Valley	Irbid	Karak	Al-Dafyaneh	Susceptible
14.0	13.3	12.8	13.6	13.1	14.5
12.9	13.6	13.2	14.0	13.1	12.0
13.4	13.1	14.0	13.2	14.0	11.0
13.5	13.2	14.3	13.5	12.8	13.5
13.1	14.0	14.2	13.6	12.5	13.6
11.9	14.0	14.0	13.4	14.9	13.0
13.0	13.0	12.9	14.2	13.2	14.0
13.3	12.9	13.9	15.0	12.8	11.9
13.5	13.8	13.7	13.5	12.7	15.0
13.6	14.2	13.4	14.6	13.1	14.0
12.9	11.7	13.3	13.7	13.2	13.1
12.7	14.1	14.0	13.3	14.1	13.6
14.5	12.3	13.4	14.0	14.5	14.1
11.0	15.1	14.2	13.5	12.6	11.5
15.0	13.3	13.2	12.4	13.1	16.3
13.7	14.1	11.9	13.4	13.3	11.4
13.5	13.9	12.9	14.8	13.7	14.3
13.7	13.8	12.3	13.5	13.2	14.0
13.3	13.9	12.9	13.7	12.9	14.2
13.1	12.2	13.4	13.4	12.9	13.7
13.9	14.1	13.4	16.0	14.0	12.1
14.3	15.5	13.1	13.7	13.3	12.9
12.7	13.4	13.0	12.8	13.8	11.9
13.6	13.6	14.1	13.6	13.5	13.6
12.9	13.6	14.0	13.8	13.6	14.3
14.9	11.5	12.9	12.9	13.2	13.2
14.0	14.6	13.1	12.5	13.3	13.7
12.5	14.8	13.3	14.6	13.3	12.5
11.7	12.7	13.5	14.0	12.9	15.3
14.1	13.1	14.0	13.7	13.7	12.9
13.7	13.7	13.6	15.0	13.9	14.1
13.5	13.9	12.8	13.0	13.9	13.8
13.1	14.0	12.3	13.1	13.7	13.0
13.9	14.3	14.0	12.8	12.5	11.9
13.8	14.1	12.4	14.3	12.9	15.0
14.2	13.5	13.2	13.2	14.0	14.0
13.9	13.2	14.5	14.7	14.1	13.4
14.3	12.9	13.8	13.0	12.9	13.9
14.0	13.7	13.2	13.7	13.2	13.0
13.1	13.9	13.1	16.3	14.1	12.9
13.0	14.1	13.1	13.2	14.1	14.0
13.0	11.9	14.0	13.8	13.5	12.6
13.6	12.7	12.5	13.7	13.2	15.1
13.9	15.5	14.0	12.6	13.9	16.0
13.7	14.1	13.2	12.2	11.9	12.2
13.3	12.8	13.3	12.7	11.7	13.9
13.5	14.9	13.3	13.8	14.9	14.9
12.7	13.5	14.0	13.7	13.1	15.0
12.5	13.5	12.1	12.9	13.5	13.5
12.6	13.7	11.1	12.6	14.0	14.0
*** 13.39 a**	**13.61 a**	**13.32 a**	**13.64 a**	**13.38 a**	**13.54 a**

* Means in the same row followed by the same letter are not significantly different at 95% confidence level.

ÇáãáÎÜÕ

ÏÑÇÓÉ ÓãíÉ ÈÚÖ ÇáãÈíÏÇÊ ÇáÍÔÑíÉ Úáì ÇáÐÈÇÈÉ ÇáãäÒáíÉ
Musca domestica L. ãä ÚÏÉ ãäÇØÞ Ýí ÇáÇÑÏä

ÅÚÜÜÜÏÇÏ

ÚÜÜÒÇã ÚÇåÜÜÜÏ ÕÜÜÜÇáÍ

ÇáãÔÑÝ

ÇáÃÓÊÇÐ ÇáÏßÊæÑ ÍÓíä ÇáãæÓì

Êã Ýí åÐå ÇáÏÑÇÓÉ ÝÍÕ ÓãíÉ ÈÚÖ ÇáãÈíÏÇÊ ÇáÍÔÑíÉ Ýí ÇáãÎÊÈÑ Úáì ÇäËì ÇáÍÔÑÉ ÇáßÇãáÉ ááÐÈÇÈÉ ÇáãäÒáíÉ *Musca domestica* L. ÈÇÓÊÎÏÇã ØÑíÞÉ ÇáãÚÇãáÉ ÇáãæÖÚíÉ. ÚæãáÊ ÇäÇË ÇáÐÈÇÈÉ ÇáãäÒáíÉ ÇáÊí ÊÊÑÇæÍ ÇÚãÇÑåÇ ãÇ Èíä 3-5 ÃíÇã ÈãÍÇáíá ÇáãÈíÏÇÊ ÈÔßá ãæÖÚí Úáì ÕÏÑ ÇáÍÔÑÉ ÇáÃæÓØ ãä ÇáäÇÍíÉ ÇáÙåÑíÉ¡ æÐáß ÈÇÓÊÎÏÇã ãÍÞä ãÏÑÌ æãÚÏ áåÐÇ ÇáÛÑÖ. æãä ÃÌá ÇáÍÕæá Úáì äÊÇÆÌ ÏÞíÞÉ¡ ÝÞÏ ÑæÚí ãÚÇãáÉ ÍÔÑÇÊ ãä äÝÓ ÇáÌäÓ æÇáÚãÑ ÊÞÑíÈÇ¡ æßÐáß ãæÖÚ ÇÖÇÝÉ ÇáãÈíÏ Úáì ÌÓã ÇáÍÔÑÉ¡ æÏÑÌÉ ÇáÍÑÇÑÉ ÈÚÏ ÇáãÚÇãáÉ ÈÇáãÈíÏÇÊ. ÓÌáÊ äÊÇÆÌ ÓãíÉ ÇáãÈíÏÇÊ ÈæÇÓØÉ ÍÓÇÈ ÇáÌÑÚÉ ÇáÞÇÊáÉ áÎãÓíä ÈÇáãÇÆÉ ãä ÇáÍÔÑÇÊ (Ì Þ 50) ÈÇáãáíßÑæÛÑÇã ãä ÇáãÇÏÉ ÇáÓÇãÉ áßá ÛÑÇã ãä ÇáÐÈÇÈ.

Êã ÌãÚ ÇáÍÔÑÇÊ ÇáßÇãáÉ ãä ÇáÐÈÇÈÉ ÇáãäÒáíÉ ÎáÇá ÇáÝÊÑÉ ÇáæÇÞÚÉ Èíä Ãíáæá 1995 æÍÒíÑÇä 1996 ãä ãÒÇÑÚ áÊÑÈíÉ ÇáÏæÇÌä Ýí ÎãÓ ãäÇØÞ ãä ÇáÇÑÏä åí : ÚãÇä¡ ÇáÛæÑ ÇáÇæÓØ¡ ÇÑÈÏ¡ ÇáßÑß æÇáÏÝíÇäå¡ ÍíË ßÇä íÊã äÞá Êáß ÇáÍÔÑÇÊ Çáì ÇáãÎÊÈÑ áÊÑÈíÊåÇ æÇáÍÕæá ãäåÇ Úáì ÇáÌíá ÇáÇæá ÇáÐí ÇÓÊÎÏã Ýí åÐå ÇáÏÑÇÓÉ. æÞÏ Êã

ÇíÖÇ ÝÍÕ äÝÓ ÇáãÈíÏÇÊ Úáì ÕäÝ ÍÓÇÓ ãä ÇáÐÈÇÈ ÇáãäÒáí ãäÔÃå ÇáÏäãÇÑß¡ æÐáß ÈÛÑÖ ãÞÇÑäÊå ãÚ ÇáÇÕäÇÝ ÇáãÍáíÉ.

ÇÔÇÑÊ ÇáäÊÇÆÌ Úáì ÇáÐÈÇÈ Ýí ãäØÞÉ ÚãÇä Çä ÇáãÈíÏÇÊ ÇáÈÇíÑËÑæíÏíÉ áÇÈãÏÇ-ÓÇíåÇáæËÑíä¡ ÏáÊÇãËÑíä¡ ÓÇíÈÑãËÑíä æÓÝáæËÑíä ßÇäÊ ÇáÇßËÑ ÝÇÚáíÉ¡ ÍíË ßÇäÊ Þíã Ì Þ$_{50}$ áåÐå ÇáãÈíÏÇÊ 1.27¡ 4.22¡ 7.08 æ 7.37 ãÇíßÑæÛÑÇã /ÛÑÇã ãä ÇáÐÈÇÈ Úáì ÇáÊæÇáí. ÊÏá åÐå ÇáÞíã ÇáÕÛíÑÉ Úáì Çä ÇáÐÈÇÈÈÉ ÇáãäÒáíÉ Ýí ÚãÇä ÍÓÇÓÉ ááãÈíÏÇÊ ÇáÈÇíËÑæíÏíÉ. æãä ÌåÉ ÇÎÑì¡ ÇÙåÑÊ ÇáäÊÇÆÌ Çä ãÇáÇËíæä æÈÑæÈßÓÑ ßÇäÇ ÇÞá ÇáãÈíÏÇÊ ÝÇÚáíÉ¡ ÍíË ßÇä ãÞÏÇÑ Ì Þ$_{50}$ 4230.47 æ 3493.30 ãÇíßÑæÛÑÇã/ÛÑÇã ãä ÇáÐÈÇÈ Úáì ÇáÊæÇáí¡ æåÐÇ íÏá Úáì Çä ÇáÐÈÇÈ ÇáãäÒáí Ýí ÚãÇä ÞÏ ÇßÊÓÈ ãÞÇæãÉ áåÐíä ÇáãÈíÏíä. ßãÇ Çä ÇáÞíã ÛíÑ ÇáßÈíÑÉ áãíá ÎØ ÇáÇÞÊÑÇä (Log. dose probit line) ÇáÎÇÕ Èßá ãä åÐíä ÇáãÈíÏíä ÊÏá Úáì ÇÍÊãÇáíÉ Çä ÊßÊÓÈ ÇáÐÈÇÈÉ ãÞÇæãÉ ÇßÈÑ Ýí ÇáãÓÊÞÈá.

Êã ÝÍÕ ÇáãÈíÏÇÊ ÓÝáæËÑíä¡ ãÇáÇËíæä æÈÑæÈæßÓÑ¡ æÇáÊí ÊãËá ÇáãÑßÈÇÊ ÇáÈÇíÑËÑæíÏíÉ¡ ÇáÝæÓÝæÑíÉ ÇáÚÖæíÉ æÇáßÇÑÈÇãÇÊíÉ Úáì ÇáÊæÇáí æÇáÊí ßÇäÊ ÇáÇÞá ÝÇÚáíÉ Ýí ãäØÞÉ ÚãÇä Úáì ÇáÐÈÇÈ ãä ÇÑÈÚ ãäÇØÞ ÇÎÑì Ýí ÇáÇÑÏä. æÞÏ ÏáÊ ÇáäÊÇÆÌ Úáì Çä ÝÇÚáíÉ ÓÝáæËÑíä Ýí ÇáãäÇØÞ ÇáÇÑÈÚ ßÇäÊ ÇßÈÑ ÈßËíÑ ãä ÝÇÚáíÉ ßá ãä ãÇáÇËíæä æÈÑæÈæßÓÑ. æÊÏá Þíã Ì Þ$_{50}$ ááãÈíÏÇÊ ÇáËáÇËÉ Úáì Çä ÇáÐÈÇÈÉ ÇáãäÒáíÉ Ýí ÌãíÚ ÇáãäÇØÞ ÍÓÇÓÉ áãÈíÏ ÓÝáæËÑíä¡ ÈíäãÇ ßÇäÊ ãÞÇæãÉ áßá ãä ãÇáÇËíæä æÈÑæÈæßÓÑ. ßãÇ Çä ÇáÞíã ÇáÕÛíÑÉ äÓÈíÇ áãíá ÎØ ÇáÇÞÊÑÇä ÇáÎÇÕ Èßá ãä ãÇáÇËíæä æÈÑæÈæßÓÑ ÊÏá Úáì Çä ãÞÇæãÉ ÇáÍÔÑÉ áßáíåãÇ ÞÏ ÊÕá Çáì ãÓÊæíÇÊ ÇÚáì Ýí ÇáãÓÊÞÈá.