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Malathion Tested for Synergism with Cypermethrin, Phosalone, Phorate and Fenitrothion on *Musca domestica* L.

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Abstract: Synergism of malathion with cypermethrin, phosalone, phorate and fenitrothion was tested against *Musca domestica* L. Malathion and other insecticides were mixed in the ratios of 1:9, 3:7, 5:5, 7:3 and 9:1 and applied topically on adult houseflies and the combined LD_{50} and co-toxicity of co-efficient were calculated after 24 h of treatment. The unsynergised malathion, cypermethrin, phosalone, phorate and fenitrothion gave topical acute LD_{50} of 606.81, 31.83, 203.95, 153.98 and 209.50 ng/fly respectively. The combined action of malathion with cypermethrin offered LD_{50} values of 6.94, 12.71, 22.44, 49.50 and 187.17 ng/fly; with phosalone 27.76, 95.31, 201.90, 411.56 and 1779.42 ng/fly; with phorate 2.40, 6.26, 67.99, 88.18 and 264.65 ng/fly; with fenitrothion 37.59, 111.66, 158.94, 320.35 and 433.79 ng/fly for 1:9, 3:7, 5:5, 7:3 and 9:1 ratios respectively. Among the tested pesticides, malathion found least toxic and in case of phorate, the degree of potentiation increased with the increase of its proportion in the mixture. The investigation revealed that the malathion could be potentiated by mixing other pesticides.

Key words: Insecticide, synergism, co-toxicity coefficient, *Musca domestica*.

Introduction

The widespread occurrence of resistance to insecticides is a serious threat to the control and management of many important insect pests (Brown and Brogdon, 1987). Resistance within or between whole classes of insecticides is an ever-increasing problem to control of major crop pests (Kanga *et al.*, 1999; Bues *et al.*, 1999; Graham and Janet, 2000; McKenzie, 2000). Given the tremendous difficulty and investment associated with development of new safe and cost effective insecticides, there is a grave need to preserve the efficacy of current and future insecticides (Mullin and Scott, 1992).

A convenient and economical method for controlling several pest problems at once is through the use of pesticide mixtures. Fungicides and insecticides are commonly used in combination for disease and insect control. There has been mounting interest in the use of synergists to reduce some of these resistance incidents by combining applications (El-Guindy *et al.*, 1983). The search for combinations of pesticides or herbicides, which have a synergistic effect on the pest or weed, whilst having no detrimental effect on the main crop is an important area of study and one that presents challenges for the statistician, as well as, for the researchers. The broad aim is to find and to describe the interaction between a number of quantitative factors and to determine a combination of levels of them which is economically optimal for a given level of control (Pike and Hasted, 1987). The result of which has greatly increased the probability of these two groups of pesticides acting together, thus presenting the potential problem of pesticide interactions in biological systems (Lichtenstein *et al.*, 1973).

Insecticide resistance in the housefly, *Musca domestica* (L.), has been recognized for many years. The rapid life cycle of houseflies in livestock farms gives a high potential for the selection of resistance when insecticides are applied intensively; such as through the repeated use of residual sprays (Keiding and Jespersen, 1986). In this proposition malathion was tested with some other pesticides to combat resistance in *M. domestica* L. by causing synergism and to find its potentiality due to interactions between malathion and any other insecticides.

Materials and Methods

The housefly (local strain) stock cultures maintained in the Crop Protection Laboratory, Department of Zoology, Rajshahi University, were used during July to December, 2000 for the study. The adults were provided with a medium to lay eggs. The medium was presented in plastic cups approximately 10 cm deep. The medium consisted of 9 gm milk powder and 5 gm fresh yeast dissolved in 100 ml of water and added to 100 gm bran following method of Wilkins and Khalequzzaman (1993). The mixture was then thoroughly stirred and put into the pots leaving 3 cm from the top. The pots were placed in the fly rearing cage for 24 h. After that time the females had laid batches of eggs. Batches of approximately 100 eggs were separated out and transferred to similar pots containing the same mixture and fitted with plastic lids with gauze centers. They were then placed in an incubator at 25 ± 0.5°C.

The insecticides were diluted in acetone and the treatments were done by topical application with 1 μl of solution of insecticide on the thoracic notum of each fly. The actual dose was calculated from the amount of active ingredient present in 1 μl of the solution. The insecticide was applied with the help of a micro syringe. The treated flies were kept in the food cup with cotton soaked in glucose solution. The mortality of the flies was recorded after 24 h of treatment.

Each trial was repeated 3 times to obtain more uniform results with a smaller error. Probit analysis was done according to Busvine (1971) using a software developed in the Department of Agricultural and Environmental Science, University of Newcastle upon Tyne, UK. The co-toxicity coefficient values were calculated as Sun and Johnson (1960). When the co-toxicity coefficient of a mixture is 100, the effect of this mixture indicates probability of similar action. If the mixture gives a coefficient significantly greater than 100, it indicates a synergistic action. On the other hand, when a mixture gives a co-toxicity coefficient less than 100, the effect of the mixture indicates an antagonistic action. In those cases where potentiation occurred the co-toxicity coefficient of mixture was divided by one hundred to obtain the degree of potentiation of malathion in that mixture (Gera and Gupta, 1978).

Results and Discussion

The dose mortality experiments with malathion, cypermethrin, phosalone, phorate and fenitrothion were carried out to find the lethal effects of different insecticides to adult housefly and the results are presented in Table 1. It was observed that the LD_{50} value was 606.81, 31.83, 203.95, 153.98 and 209.50 ng/fly for malathion, cypermethrin, phosalone, phorate and fenitrothion respectively. The results indicate that cypermethrin was the most toxic and malathion was the least toxic to adult housefly when applied singly. The regression equations of the expected probit on log dose have also been

Table 1: LD_{50}, 95% confidence limit and regression of different insecticides on adult housefly.

Insecticide	LD_{50} ng/gly	95% Confidence limits		Regression equation
		Lower ng/gly	Upper ng/gly	
Malathion	606.812	415.170	886.919	Y=0.6306115+1.5769998X
Cypermethrin	31.839	23.991	42.260	Y=2.256077+1.825692X
Phosalone	203.947	158.930	261.720	Y=0.1010897+2.120794X
Phorate	153.980	117.930	202.490	Y=-0.2899528+2.425039X
Fenitrothion	209.500	152.160	288.460	Y=0.9837418+1.730264X

Table 2: LD_{50}, cotoxicity-co-efficient, degree of potentiation, 95% confidence limits and regression equation of different insecticides on adult housefly.

Insecticide mixtures Ratio	LD_{50}	Co-toxicity ng/gly	Degree of coefficient	Regression equation potentiation
Mal.+Cypermethrin				
1:9	6.939	87449.488	874.495	Y=3.104112+2.25342X
3:7	12.711	15913.875	159.139	Y=2.487117+2.275819X
5:5	22.441	5408.017	54.080	Y=2.256072+2.030964X
7:3	49.501	1751.235	17.512	Y=1.193135+2.246452X
9:1	187.167	360.233	3.602	Y=-1.470055+2.847449X
Mal.+Phosalone				
1:9	27.758	21860.796	218.608	Y=1.747425+2.253425X
3:7	95.311	2122.224	21.222	Y=0.1986256+2.425987X
5:5	201.904	601.089	6.011	Y=0.273202+2.050542X
7:3	411.563	210.089	2.106	Y=0.7468319+1.883892X
9:1	1779.424	37.890	0.379	Y=-1.562096+2.018933X
Mal.+Phorate				
1:9	2.405	252417.630	2524.176	Y=2.55034+1.773798X
3:7	6.261	32308.167	323.082	Y=3.825075+1.474861X
5:5	67.989	1738.021	17.340	Y=1.800657+1.734033X
7:3	88.185	983.019	9.830	Y=1.863896+1.612066X
9:1	264.646	254.769	2.550	Y=1.187306+1.57376X
Mal.+Fenitrothion				
1:9	37.588	16143.769	161.438	Y=2.804716+1.393783X
3:7	111.658	1811.519	18.115	Y=-1.090871+2.974217X
5:5	158.939	763.574	7.636	Y=0.627348+1.986456X
7:3	320.354	270.598	2.706	Y=0.7918558+1.679475X
9:1	433.795	155.427	1.554	Y=0.3522682+1.909247X

Mal. = Malathion

presented in Table 1.

The dose mortality experiment was done with malathion and other insecticides in the proportion of 1:9, 3:7, 5:5, 7:3 and 9:1 to find out the lethal effect of insecticide mixtures to adult housefly. The combined action of malathion with cypermethrin offered LD_{50} values of 6.94, 12.71, 22.44, 49.50 and 187.17 ng/fly; with phosalone 27.76, 95.31, 201.90, 411.56 and 1779.42 ng/fly; with phorate 2.40, 6.26, 67.99, 88.18 and 264.65 ng/fly; with fenitrothion 37.59, 111.66, 158.94, 320.35 and 433.79 ng/fly for 1:9, 3:7, 5:5, 7:3 and 9:1 ratios respectively (Table 2). The co-toxicity coefficients of the mixtures of malathion and other insecticides indicate that phorate synergised the activity of malathion at its higher proportion (1:9) in the mixture against housefly. Here all ratios tested were acted as synergist and probably they worked by preventing the detoxification mechanism of the insect. Minimum potentiation was in the mixture in which malathion and fenitrothion was in the ratio of 9:1. The same ratio of malathion with phosalone shows antagonism because their co-toxicity coefficient value was only 37.89.

In most of the information joint action of mixtures, more papers discuss the use of mixtures than report actual research (Georghiou, 1983). In case where mixtures have been applied, the results have been positive, negative and inconclusive, apparently as a function of the care with which the components of the mixture were chosen (Georghiou, 1980). Successful delay of resistance through the use of mixtures (Burden *et al.*, 1960; Asquith, 1961; Graves *et al.*, 1967; Ozaki *et al.*, 1973) may be exemplified by the work of Pimental and Bellotti (1976), in which houseflies evolved resistance to each of six insecticides when used singly, but were apparently unable to develop resistance to a mixture of the components. Piperonyl butoxide (PBO), which inhibits mixed-function oxidases (Farnham, 1998) and triphenyl phosphate (TPP), which inhibits carboxyesterases (Plapp *et al.*, 1963), were used by Picollo *et al.* (2000) on permethrin-resistant colonies of *Pediculus capitis* (De Geer) and observed that the combined permethrin-PBO or TPP treatment produced lower LC_{50}.

The application of insecticides formulated as baits against adult houseflies and used in combination with larvicide treatment of the manure has been shown to be a successful treatment strategy causing a low selective pressure (Keiding, 1986; Keiding *et al.*, 1992).

The result obtained from this study reveals that the toxic effect of malathion can be potentiated by a number of insecticides and that the proportion in which the insecticides are mixed is a material difference. Maximum toxicity of a particular insecticide combination can only be obtained by finding their optimum proportion by experimentation and not by mere speculation. It is quite possible that the mixtures may give even better result when mixed in other proportion, which has not tried in the present investigation.

Results of joint toxicity expressed as co-toxicity coefficient can be used not only for the evaluation of joint action of insecticide mixtures in the laboratory but also for the estimation of dosages of each toxicant in insecticides mixtures for primarily done field tests. For example, when two different types of insect pests are present on the same crop at the same time, two kinds of insecticides are used for their control although each toxicant in the mixture is used for control of a special type of pest. It may also have same effectiveness against another type. If one has obtained the data on the effectiveness of each toxicant against each pest the toxicant needed in the mixture should be less than the doses when applied alone. By means of calculating their joint toxicity an approximate ratio of toxicant can be obtained for preliminary field tests with new combinations.

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