Pertanika 6(1), 22–27 (1983)

The Effect of Malathion on the Weight, Fecundity and Longevity of *Ischiodon scutellaris* Fabr. (Diptera: Syrphidae)

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Key words: **Malathion;** *Ischiodon scutellaris;* **sub-lethal doses**

RINGKASAN

Kesan-kesan dosis malathion sub-maut pada berat badan, fekunditi dan panjang umur Ischiodon scutellaris *Fabr. telah dikaji. LD_{50} bagi malathion yang diletak di atas badan instar larva ketiga adalah 26.9×10^{-2} (24 jam) dan 18.7×10^{-2} (48 jam) µg/larva; nilai LD_{95} adalah 146×10^{-2} (24 jam) dan 127.6×10^{-2} (48 jam) µg/larva.*

Perbezaan di antara berat badan dan panjang umur serangga betina diberi malathion pada peringkat instar larva ketiga adalah bererti (pada aras 5%) dengan dosis malathion yang berlainan. Perbezaan berat badan (pada aras 5%) adalah dikesankan juga di antara pupa yang diberi malathion pada peringkat larva.

Malathion menunjuk keracunan terpendam. LD_{50} untuk ketoksinan langsung adalah 41.7×10^{-2} µg/larva dan bagi jumlah ketoksinan adalah 21.4×10^{-2} µg/larva.

SUMMARY

The effects of sub-lethal doses of malathion on the weight, fecundity and longevity of Ischiodon scutellaris *Fabr. were studied. The LD_{50} values for malathion, applied topically to the third instar larvae, were 26.9×10^{-2} (24h) and 18.7×10^{-2} (48h) µg/larva; the LD_{95} values were 146×10^{-2} (24h) and 127.6×10^{-2} (48h) µg/larva.*

There was a significant difference (at 5% level) in the weight and longevity of female flies treated, at the third larval instar stage, with different doses of malathion. A similar weight difference (at 5% level) was noted between pupae treated at the larval stage.

Measurable latent toxicity was evident for malathion. The LD_{50} for direct toxicity was 41.7×10^{-2} µg/larva and for total toxicity it was 21.4×10^{-2} µg/larva.

INTRODUCTION

Ischiodon scutellaris Fabr. is one of three common aphidophagous syrphids found in West Malaysia (Phoon, 1973). It occurs all year round in open fields, on road side vegetation and in plantations and gardens. It has a variable longevity and fecundity in captivity (depending on the availability of pollen), with a preference for *Aphis craccivora* Koch, and is highly dependent on aphid odour for oviposition. Studies on the biology and ecology of several species of aphidophagous syrphids suggest that they would be useful agents for biological control of aphids in Malaysia (Phoon, 1973).

The use of entomophagous insects in any integrated control programme can be fully realized only if their susceptibility to insecticides is known. There is considerable literature to show that insecticides affect insect parasites and predators. Studies on several species of predaceous coccinellids indicate that, at sub-lethal doses, insecticides can affect longevity and fecundity of these insects.

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For example, Parker *et al.*, (1976) showed that sub-lethal doses of malathion affected the fecundity and longevity of the coccinellid, *Menochilus sexmaculatus* F. Similar effects have been noted for other insects such as houseflies (Georghiou, 1965), *Coleomegilla maculata* De Beer (Atallah and Newsom, 1966), *Prodenia litura* F. (Salam-Abdel and Nasr, 1968), *Plodia interpunctella* Hubner (Soderstrom and Lovitt, 1970) and *Spodoptera littoralis* Bois. (Abo-Elghar *et al.*, 1972). More recently, it was shown that sub-lethal doses of several commonly used insecticides such as carbaryl, carbofuran, permethrin and decamethrin affected the longevity and/or fecundity of the female western corn root worm (Ball and Su, 1978), the tsetse fly (Kwan and Gatehouse, 1978) and the brown planthopper (Chelliah *et al.*, 1980).

This work was undertaken to determine the effect of malathion, a broad spectrum insecticide used in Malaysia, on the weight, fecundity and longevity of the aphid predator, *I. scutellaris*.

MATERIALS AND METHODS

I. scutellaris larvae were collected from aphid-infested maize in the Universiti Pertanian Malaysia campus, Serdang. They were fed on *Aphis spiraecola* Patch collected from the shoots of Siam weed (*Chromolaena odorata*). Adult flies were daily provided with flowers of *Cleome ciliata* Schum and Thorm. (as a source of pollen) and 15% honey solution soaked in wad of cotton wool. Glass vials (5 × 2.5cm) with perforated covers were used to contain the larvae. Seven to ten newly hatched larvae were transferred by a soft hair brush to each vial and an excess of aphids was provided to minimise cannibalism. Both syrphid larvae and adults were reared at 26° ± 2°C and 64%–90% R.H.

To determine the LD_{50} for malathion (diethyl mercaptosuccinate), third instar (5-day old) larvae were topically dosed with 1 µl of several concentrations (from 25 µg/ml to 250 µg/ml) of 96% malathion in analar acetone, using a Drummond micro-applicator. Controls were treated with acetone only. Each treatment was replicated five times, each replicate consisting of from five to ten larvae. Treated larvae were fed on aphids as indicated. Mortality was recorded 24h and 48h after treatment. The data were analysed by Finney's (1964) probit method using the University of Malaya computer.

Adults which emerged from treatment at the third-instar stage, were transferred into circular plastic containers (10 × 6.5cm) and fed with honey and pollen. A minimum of four flies per treatment was used. Survival counts were made daily.

To study the effect of sub-lethal doses of malathion on the fecundity and life span of adult flies treated at the third-instar stage, a fresh batch of larvae was treated with different malathion concentrations as described above and allowed to pupate. Emerging female flies were placed individually into plastic cages with one male fly per cage. Every evening the flies were transferred into fresh plastic bowls to induce egg laying. As usual, honey, excess aphids and pollen were provided. The pre-oviposition period from the day of adult emergence was noted and egg counts were made daily and their hatchability recorded.

Direct toxicity was determined by noting the number of insects killed prior to the completion of the pupal stage or during the emergence of adults. Partial emergence or adults with unexpanded wings were counted as affected. Total toxicity was determined by total mortality occurring within three days after adult emergence. The difference between the median-lethal doses of the direct and total toxicities was used to estimate the latent toxicity (Sherman and Sanchez, 1962).

RESULTS AND DISCUSSION

The probit analyses data for dose versus mortality are given in Table 1. If the LD_{50} values, in mg/1, for 24h and 48h, are converted to µg per larva, the figures obtained are 26.86×10^{-2} and 18.72×10^{-2} respectively. For LD_{95} the values are 145.97×10^{-2} (for 24h) and 127.57×10^{-2} (for 48h) µg/larva. The LD_{50} and LD_{95} values for 48h, adjusted to mg larva weight, based on average larva weight of 14.45mg, are 1.30×10^{-2} and 8.83×10^{-2} µg/mg larva weight.

The sensitivity of syrphid larvae to insecticides has been shown by Meier (1965). He found that DDT not only affected young syrphid larvae but that the sensitivity of coccinellid larvae to DDT and Dieldrin decreases with advancing age of the insects. Zeleny (1965) reported similar results for fenitrothion and malathion against the larvae of *Coccinella septempuntata* L. and *Chrysopa perla* L. Also, malathion was found to be comparatively more toxic to *Menochilus sexmaculatus* larvae than adults (Parker *et al.*, 1976).

Table 2 gives the average lifespan and the weight of pupae and adult flies, treated at the third larval instar stage, with sub-lethal doses

TABLE 1
Probit analyses data for malathion applied topically to third instar larvae of *I. scutellaris*

Duration after application	Slope b ± S.E.	Chi sq	D.F.	LD_{50} ± S.E. (mg/l)	(LD_{95})	95% Confidence Limits of LD_{50}	
						Lower	Upper
24 hr.	2.237 ± 0.80	1.5	3	268.6 ± 0.95	(1459.7)	29.8	2419.0
48 hr.	1.974 ± 0.54	1.8	3	187.2 ± 0.56	(1275.7)	51.2	684.8

of malathion. An analysis of variance showed a significant difference (at 5% level) in the weight and lifespan of adults between some of the treatments; similar differences were also noted in the pupal weights and in the duration of the pupal stages. The decrease in adult weight with increasing sub-lethal doses of an organophosphate is not unknown for poisoned insects. Under adverse stimuli insects may pupate early resulting in smaller adults which may be less fecund. Other causes may also play a part. Weight loss in parathion-poisoned *Leptinotarsa decemlineata* and *Bombyx mori* has been attributed to water loss primarily by regurgitation (Jochum, 1956). *I. scutellaris* larvae do void a black excrement just before pupation (Phoon, 1973), but as this is characteristic of syrphid larvae, no data were recorded with regard to the amount and content of the liquid excreted in this study.

An analysis of variance showed no significant difference (at 5% level) in the pre-oviposition period. However, increasing doses of malathion resulted in females with decreasing weight and reduced longevity. This in turn affected the total number of eggs laid per female during its life span and the resultant number of eggs hatching. (Table 3).

It has been reported that increasing doses of malathion affected the fecundity and egg-laying period of insects such as *Plodia interpunctata* Hub. (Soderstrom and Lovitt, 1970). *Musca domestica* L. (Ouye and Knutson, 1957), and *Menochilus sexmaculatus* F. (Parker *et al.*, 1976). However, it is not easy to identify the cause(s) of these effects. Adult pink bollworms that survived low doses of DDT lived fewer days and produced fewer eggs than the controls and it was suggested that this was due to a lower incidence of mating, shortened life span and other undetermined physiological effects (Adkisson and Wellso, 1962). Whether this is true for malathion is difficult to say without more detailed work.

Measurable latent toxicity to malathion is evident in that the LD_{50} for direct toxicity, 41.69×10^{-2} µg/larva, is greater than the total toxicity, 21.38×10^{-2} µg/larva. This is anomalous since organochlorine and not organophosphate insecticides have been shown to produce latent toxicity in other insects (Sherman and Sanchez, 1962; Yates and Sherman, 1970). Latent toxicity is dependent on the ability of the insecticide to penetrate the integument and on the rate and degree of its detoxification. Also, as shown by Sherman and Sanchez (1962), the structure of the compound and the species and the latter's susceptibility to the chemical, play a part. One plausible reason for the detectable latent toxicity for malathion may be due to the parasitism of the pupae but this was not confirmed.

Although malathion does not have an overall deleterious effect on *I. scutellaris* larvae exposed to it at sub-lethal doses as do chlorinated hydrocarbons on other species, it does show some effect on the biology of the flies. With the reduction in longevity and fecundity of the emerged females, their potency as natural enemies in the field will be reduced. This alone merits further research so that suitable insecticides may be used in integrated control programmes.

ACKNOWLEDGEMENTS

We thank the Head, Department of Zoology, University of Malaya for the use of Departmental facilities in carrying out this work and Dr. Ramli Abdullah of the same Department, for his help with the translation of the summary.

TABLE 2
The effect of sub-lethal doses of malathion on pupal and adult stages of *I. scutellaris* treated at the third larvae instar stage (Date based on 12 to 24 individuals per treatment)

	Treatment					
	Acetone control Mean ± SE	Malathion Mean ± SE				
		25 μg/ml	100 μg/ml	150 μg/ml	200 μg/ml	250 μg/ml
Observations	1	2	3	4	5	6
Weight of pupa (mg)	16.38±0.74ab	16.54±0.74ab	18.89±0.83a	15.59±0.83b	14.76±0.94b	15.08±1.00b
Duration of pupal stage (days)	6.00±0.19ab	6.20±0.22ab	6.50±0.24a	5.70±0.25b	5.60±0.25b	5.70±0.27b
Adult weight, mixed sexes (mg)	11.36±0.42a	9.08±0.49b	10.89±0.52ac	9.59±0.54bc	8.92±0.54b	9.50±0.58b
Longevity of adults mixed sexes (days)	24.10±1.40a	23.47±1.55ab	19.29±1.71bc	16.17±1.85c	17.42±1.85c	10.30±2.03d

Means in horizontal rows bearing the same letter are not significantly different at 5%.

TABLE 3
The effect of sub-lethal doses of malathion on adult *I. scutellaris* treated at the third larval instar stage
(The data represents observations from 5-11 flies per treatment)

Observations	Acetone control Mean ± SE	Malathion Mean ± SE				
		25 μg/ml	100 μg/ml	150 μg/ml	200 μg/ml	250 μg/ml
Pre-oviposition period (days)	5.00±0.60a	5.44±0.63a	4.86±0.71a	4.83±0.77a	5.60±0.84a	4.00±0.95a
Weight of females (mg)	12.20±0.62a	10.10±0.69b	10.80±0.73ab	9.90±0.79b	8.90±0.79b	9.40±0.84b
Longevity of females (days)	27.40±2.05a	26.78±2.16ab	20.43±2.45bc	19.43±2.45c	11.00±2.65cd	7.17±2.65d
Total No. eggs laid/lifespan	244.10±33.96a	288.90±39.80a	146.10±45.05b	108.20±48.73bc	62.20±53.30d	67.30±59.70cd
Total No. of eggs hatched in 3 days	180.40±25.01a	160.00±26.34abc	97.70±29.83bc	51.67±32.26cd	34.20±35.29de	22.50±39.50e
% of eggs hatched in 3 days	73.95	55.38	66.86	47.77	54.98	33.46

Means within rows bearing the same letters are not significantly different at the 5% level.

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(Received 13 May 1982)