COMPARATIVE TOXICITY OF INSECTICIDES TO LUCERNE APHIDS AND THEIR PREDATORS

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Summary

The insecticides pirimicarb, fenvalerate, chlorpyrifos and demeton-S-methyl were tested against bluegreen lucerne aphid (BGLA) (*Acyrtosiphon kondoi*), pea aphid (PA) (*A. pisum*) and two of their natural enemies, the brown lacewing (*Austromicromus tasmaniae*) and the 11-spotted ladybird (*Coccinella undecimpunctata*) by topical application. LD₅₀ values were determined. Pirimicarb was 1,000-10,000 times more toxic to aphids than to predators while the equivalent factors for fenvalerate and demeton-S-methyl were 5-1,000 and 16-400 respectively. Chlorpyrifos showed the same order of toxicity to both predators and aphids.

INTRODUCTION

Although the natural enemy complex of lucerne aphids is not diverse, Cameron *et al* (1978) have remarked that on occasions the 11-spotted ladybird has been known to provide complete control of aphid populations. Another common predator is the brown lacewing (Thomas 1977; Cameron *et al* 1978). Natural enemies alone do not provide adequate consistent control of aphids, but it is suggested that, when insecticides are required, they should be used in such a way as to minimise disruption of existing enemy populations. One way of achieving this is to apply selective insecticides only. Croft and Brown (1975) commented that there have been few studies in which insecticides have been tested against predators and their prey by the same method. This study, therefore, investigated the toxicity of four insecticides to BGLA and PA as well as to two of their natural enemies, the brown lacewing and the 11-spotted ladybird.

METHODS AND MATERIALS

Most insects used in the testing programme were collected from field populations. A sweep net was used to collect predators but, whenever populations were sufficiently high, aphids were obtained by picking lucerne stems. Sweeping caused considerable damage to aphids. PA was reared in a glasshouse on broad bean plants (*Vicia faba*, cv 'Exhibition Long Pod') and these aphids were used for tests with all insecticides except chlorpyrifos when PA were field collected from lucerne. All BGLA used for testing were collected from the field. Lacewing larvae were reared in the laboratory under constant temperature conditions ($20 \pm 1^\circ\text{C}$) in a similar manner to that described by Hilson (1964).

Technical grade insecticides were applied topically in acetone by means of a 100 μl SGE (Scientific Glass Engineering Pty., Australia) syringe positioned in an Arnold[®] applicator (manufactured by Burkard Manufacturing Co., England). The size of droplet was chosen to be roughly in proportion to the body mass of the insects. For BGLA this was $0.050 \pm 0.002\mu\text{l}$, for PA, brown lacewing adults and third instar larvae a droplet of $0.100 \pm 0.003\mu\text{l}$ was applied, and the 11-spotted ladybirds were dosed with $0.380 \pm 0.015\mu\text{l}$. Dosing was carried out at $10 \pm 2^\circ\text{C}$ in a 'walk-in' constant temperature room which ensured a constant rate of solvent evaporation. The low temperature also allowed all insects except for brown lacewing adults to be handled without anaesthesia. Adult brown lacewings were given a 30 second exposure to carbon

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dioxide before dosing. Three groups of 20 insects were dosed at each of five concentrations of insecticide, and with acetone as a control. Mortality counts were made 48 h after treatment for brown lacewings (both adults and larvae) and for the 11-spotted ladybird, but aphids were checked only 24 h after dosing. This shorter time was chosen because of the aphid's shorter lifespan.

During the post-treatment period, aphids were maintained in 30 ml (75 mm long) specimen tubes having a 10-15 mm layer of agar in the bottom. A 40-50 mm shoot of lucerne (*Medicago sativa*, cv. 'Wairau') was pushed into the agar. This kept the shoot fresh for several days. Predators were kept in petri dishes, 20 to each dish. Brown lacewings were provided with food but 11-spotted ladybirds were not. A constant post-treatment temperature of $15 \pm 1^\circ\text{C}$ was maintained for brown lacewings and 11-spotted ladybirds except for the tests involving demeton-S-methyl in which the post-treatment temperature was $20 \pm 1^\circ\text{C}$. Aphids were held at $10 \pm 1^\circ\text{C}$.

Different criteria for assessing mortality were used for the different insect species. When held by a suction device and if necessary prodded with a brush, healthy 11-spotted ladybirds made vigorous movements of legs and antennae. Often poisoned insects did not retract these appendages properly. The ability to fly normally was found to be the most reliable test for brown lacewing adults, while normal locomotory behaviour was used to indicate healthy individuals among treated aphids and lacewing larvae.

Log-probit regression lines and 95% confidence intervals for the LD_{50} values were calculated by means of a computer programme based on Finney (1971). In order that LD_{50} values could be calculated, the mean mass of each type of insect was calculated by weighing at least ten groups of 20 individuals selected randomly from the insects undergoing testing. It was assumed that the insects selected, both for weighing and for testing, contained a random distribution of males and females.

RESULTS AND DISCUSSION

LD_{50} values, with 95% confidence intervals where these are valid (Finney 1971) are presented in Table 1. Results indicate a marked selectivity of pirimicarb against BGLA and PA compared with the natural enemies. Brown lacewing larvae were extremely tolerant. Even when applied at a concentration of 20g/litre pirimicarb did not cause significant mortality. The 11-spotted ladybird was 5-10 times more tolerant of fenvalerate than the aphid species while brown lacewing adults were 60-120 times as tolerant as the aphids. Brown lacewing larvae were 15 times more tolerant than the adults. Demeton-S-methyl showed some selectivity between natural enemies and aphids, the brown lacewing adult was more tolerant than the 11-spotted ladybird. For all insecticides tested the brown lacewing larvae proved to be more tolerant than the adults. Where the difference between the responses of the two aphid species was significant (for fenvalerate and chlorpyrifos) BGLA was more tolerant than PA.

TABLE 1: LD_{50} (mg/kg) for insecticides topically applied to lucerne aphids and their predators ($\pm$ 95% confidence limits where valid).

Species	Insecticide			
	pirimicarb	chlorpyrifos	fenvalerate	demeton-S-methyl
BGLA	0.13	0.87 ± 0.14	0.071 ± 0.015	0.054 ± 0.011
Pea aphid	0.057 ± 0.010	0.38 ± 0.13	0.033 ± 0.010	0.12
Brown lacewing (adult)	470 ± 110	0.55 ± 0.11	4.3 ± 0.9	5.8 ± 1.1
Brown lacewing (larva)	$\gg 1600$	2.3 ± 1.0	67 ± 18	52 ± 11
11-spotted ladybird	130 ± 25	1.9 ± 0.9	0.38 ± 0.08	1.9 ± 0.03

Kay (1979) investigated the toxicity of a number of insecticides to the ladybird *Coccinella repanda* by topical application and found that pirimicarb was among the least toxic to both larvae and adults. Demeton-S-methyl was more toxic than

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chlorpyrifos, but it should be noted that while in the present study these chemicals showed the same degree of toxicity to the 11-spotted ladybird, demeton-S-methyl was significantly more toxic to aphids than chlorpyrifos. Kay (1979) also found that in general larvae of *C. repanda* were significantly more susceptible than adults, which is in contrast to results for brown lacewings in the present study.

CONCLUSIONS

With increasing economic and environmental costs of insecticides it becomes imperative that other methods of pest control be employed wherever possible. Thus, insecticides which selectively destroy pest species while having a less severe impact on natural enemies may be required less frequently, and often at lower dosages, than broad spectrum compounds. These laboratory studies have shown that pirimicarb, and to a lesser extent fenvalerate, are markedly selective, while demeton-S-methyl is more selective than chlorpyrifos, against lucerne aphids compared to the two most commonly observed natural enemies.

Experiments such as these, performed under laboratory conditions, cannot duplicate exactly the interaction between field populations of insects and insecticide spray treatments. It is important that results from laboratory studies are supported by investigations carried out in the field. Field tests in California have shown that low rates of pirimicarb were the least disruptive of a number of treatments to three species of predators on PA (Summers *et al* 1975), and O'Connor and Hart (1977) have reported on the effect in New Zealand of pirimicarb at different rates on BGLA numbers, but there remains a need for further quantitative study on the effect of insecticide treatment on populations of lucerne aphids and predators in the field.

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REFERENCES

- Cameron, P.J., Thomas, W.R. and Hill, R.L. 1978. Introduction of lucerne aphid parasites and a preliminary evaluation of the natural enemies of *Acyrtosiphon* spp. in New Zealand. *Proc. 2nd Aust. Conf. Grassland Invert. Ecology* (In press).
- Croft, B.A. and Brown, A.W.A., 1975. Responses of arthropod natural enemies to insecticides. *A. Rev. Ent.* 20: 285-335.
- Finney, D.J., 1971. *Probit Analysis* 3rd ed. Camb. Univ. Press 318 pp.
- Hilson, R.J.D., 1964. *The ecology of Micromus tasmaniae Walker*, Thesis, M.Sc., University of Canterbury, New Zealand.
- Kay, I.R., 1979. Toxicity of insecticides to *Coccinella repanda* Thunberg (Coleoptera: Coccinellidae). *J. Aust. ent. Soc.* 18: 233-234.
- O'Connor, G.P. and Hart, R.J.K., 1977. Pirimicarb for the control of bluegreen lucerne aphid. *Proc. 30th N.Z. Weed and Pest Control Conf.*: 270-172.
- Summers, C.G., Coviello, R.L. and Cothran, W.R., 1975. The effect on selected entomophagous insects of insecticides applied for pea aphid control in alfalfa. *Environ. Ent.* 4: 612-614.
- Thomas, W.P., 1977. Biological control of the bluegreen lucerne aphid. The Canterbury situation. *Proc. 30th N.Z. Weed and Pest Control Conf.*: 182-187.