ACTIVITY OF RH7988 AGAINST APHIDS AND THEIR NATURAL ENEMIES

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SUMMARY

The toxicity of RH7988 to cabbage aphid (CA), *Brevicoryne brassicae*, and green peach aphid (GPA), *Myzus persicae*, did not change significantly between 10 and 30 °C and was not significantly different to pirimicarb against GPA. On newly emerged leaves, 23 days after insecticide application, RH7988 at 0.2 g/litre left 61% GPA moribund, c.f. 5% for pirimicarb at 0.5 g/litre ($P < 0.05$). The recommended field concentration of RH7988 (0.2 g/litre) was more toxic towards the two aphid species, than to several natural enemy species.

INTRODUCTION

The emphasis in pest management at present is to prevent economic damage from occurring to a crop, with minimal disruption to non-target organisms. Use of pesticides that are selective towards the target pest is one means of achieving this.

RH7988, a selective insecticide (Murray *et al* 1988), under development by Rohm and Haas Co., is being assessed for control of aphids in agricultural and horticultural crops. The results of laboratory and field trials reported by Herman and Chapman (1989), have shown that RH7988 is at least as toxic as pirimicarb to green peach aphid (GPA) and cabbage aphid (CA). RH7988 also had a greater systemic action than pirimicarb against CA.

From these earlier trials the following questions were formulated: (a) what was the effect of temperature on the toxicity of RH7988 and pirimicarb, (b) what was the residual activity of RH7988 against GPA, (c) how toxic was RH7988 to natural enemies? Laboratory experiments were set up to answer these questions and the results are presented in this paper.

MATERIALS AND METHODS

Temperature-toxicity relationship

The LC₅₀ concentrations of RH7988 (250 g/kg WP), 41.7 and 19.0 mg/litre for GPA and CA respectively, and pirimicarb (500 g/kg WDG), 73.5 and 16.5 mg/litre for GPA and CA respectively, which were calculated in earlier experiments (Herman and Chapman 1989), were tested over a range of temperatures (10, 15, 20, 25 and 30 °C) for both aphid species.

The insecticides (including 0.3 ml/litre Triton B1956 surfactant) were applied to adult or penultimate instar nymphs on leaf discs (five aphids per disc, three discs per petri dish) using a Potter tower (2 ml applied at 103 kPa, allowing a 10 second settling time). Treated dishes were maintained at constant temperatures and counts of those aphids that were moribund (responded to prodding but were not showing normal activity) were made 24 hours post treatment. The counts were corrected for the control moribundity. Each temperature was initially replicated three times, but the number of replicates was then increased (maximum of seven) to improve the precision of the estimates.

Regression analysis was carried out on the temperature-toxicity data and confidence intervals calculated using Minitab.

Residual activity

A pot trial was carried out in an insectary, to assess the residual activity of RH7988 in cabbage ('Golden Acre' Merit Strain) on GPA. Six treatments (plus a control) were

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applied (Table 2) and were replicated five times. All treatments included 0.3 ml/litre Triton B1956 and applications were made using a precision plot sprayer (water rate equivalent to 500 litres/ha), when the cabbage plants had 3-4 true leaves.

Five green peach aphid apterae were caged on leaves 1, 4, 10, 20 and 30 days post treatment. Counts of those that were moribund were made 24 hours after caging. Counts of aphids on leaves that had emerged after spraying were made 23 and 27 days post treatment. All counts were corrected for control moribundity.

Analysis of variance was carried out on the data from the residual activity experiment and means were separated using a least significance difference test.

Toxicity to natural enemies

Various natural enemies of aphids (Table 3) were placed in petri dishes immediately after treatment (in a Potter tower) with RH7988 at 0.2 and 0.4 g/litre (including 0.3 ml/litre Triton B1956). Adult lacewings and Hymenoptera were anaesthetised with CO₂ for ease of handling. Counts of those aphids that were moribund were made after 24 hours incubation at 20 °C. The counts were corrected for the control moribundity.

RESULTS

Temperature-toxicity relationship

The (corrected) toxicity of RH7988 and pirimicarb, to both aphid species, did not change significantly over the temperature range that was tested (Table 1). The 95% confidence intervals for the percentage of moribund aphids overlapped and the slopes of fitted regressions were low. Regressions fitted, for both insecticides, were significant ($P < 0.05$) for CA, but were not significant ($P > 0.05$) for GPA.

TABLE 1: The effect of temperature on the toxicity of RH7988.

Species and insecticide	Temperature (°C)				
	10	15	20	25	30
Corrected mean % moribund aphids (95% confidence intervals)					
Cabbage aphid					
RH7988	65.2	61.7	70.3	76.0	97.7
y = 0.438 + 0.0145 × temp	(41.4-89.0)	(43.8-79.7)	(55.3-85.3)	(62.1-89.9)	(87.6-100.0)
P = 0.007					
pirimicarb	62.3	75.6	98.0	95.7	95.3
y = 0.506 + 0.0173 × temp	(25.0-99.6)	(58.4-92.8)	(98.0-98.0)	(85.6-100.0)	(85.3-100.0)
P = 0.001					
Green peach aphid					
RH7988	74.3	72.4	82.2	84.3	78.8
y = 0.694 + 0.0042 × temp	(64.9-84.7)	(56.0-88.8)	(68.4-96.0)	(76.4-92.3)	(65.0-92.6)
P = 0.285					
pirimicarb	95.7	87.8	95.3	88.3	81.8
y = 1.01 − 0.0059 × temp	(77.0-100.0)	(69.0-100.0)	(83.7-100.0)	(72.2-100.0)	(62.3-100.0)
P = 0.097					

Residual activity

RH7988 at 0.1 g/litre had significantly fewer moribund GPA than pirimicarb after the treatment residues had been aged for 1 day (Table 2), but had significantly more moribund GPA 10 and 20 days after treatment. After 4 and 10 days RH7988 at 0.4 g/litre had significantly more moribund GPA than pirimicarb and lower rates of RH7988. The treatments were not significantly different 20 days after treatment.

More moribund GPA were recorded on leaves that had emerged after spraying (23 and 27 days after treatment) than on leaves that were sprayed 20 days previously. RH7988 at 0.4 g/litre had significantly ($P < 0.05$) more moribund GPA than pirimicarb at 23 and 27 days after treatment and at the higher rate this effect continued through to 27 days after treatment.

TABLE 2: Percentage of moribund green peach aphid 24 hours after exposure to treated cabbage leaves.

Insecticide and rate (g ai/litre)	Days after treatment					
	1	4	10	20	23*	27*
	Mean % moribund aphids					
RH7988						
0.05	75	10	18	0	9	4
0.1	40	39	35	4	4	0
0.15	72	50	23	0	10	30
0.2	72	40	15	0	61	19
0.4	80	78	90	0	55	34
pirimicarb						
0.5	68	44	12	0	5	4
LSD _{0.05}	27.0	23.2	19.1	3.1	15.5	18.6

*counts on leaves that emerged after spraying

Toxicity to natural enemies

The mean percentages of natural enemies that were moribund 24 hours after treatment are presented in Table 3. The two ladybird species were not affected by RH7988. RH7988 was more toxic to the adult lacewings than the third instar lacewing larvae. The hymenopteran parasitoids were the most affected of the natural enemies tested. For all natural enemies the difference between the two rates of RH7988 was not significant.

TABLE 3: Toxicity of RH7988 to natural enemies of aphids.

Species	Stage	Rate (mg ai/litre)	Corrected % moribund	SEM
<i>Micromus tasmaniae</i> (Tasmanian lacewing)	larvae	0.2	29.7	9.6
		0.4	34.4	13.7
	adult	0.2	47.5	10.0
		0.4	47.5	10.0
<i>Coccinella leonina</i> (orangespotted ladybird)	adult	0.2	0	0
<i>C. undecimpunctata</i> (eleven-spotted ladybird)		0.4	0	0
<i>Diaeretiella rapae</i>	adult	0.2	59.3	24.8
<i>Alloxysta infusata</i>		0.4	63.3	27.3

DISCUSSION

Over the range of temperatures that would normally be encountered in the field, the efficacy of RH7988 and pirimicarb did not change markedly for either aphid species. McLeod (1987) reported similar results for RH7988 with GPA, finding no significant difference between LC₅₀ values at 8, 16, 24 and 32 °C. In the same experiment, pirimicarb showed a positive temperature coefficient between 8 and 32 °C with GPA. This differs from our results and could be due to different test methods or strains of aphids used in the experiments.

As was observed with CA (Herman and Chapman 1989) and reported by Murray *et al* (1988), RH7988 had good systemic activity. In the experiment reported here, RH7988 caused a significantly larger percentage of GPA to become moribund on leaves that emerged subsequent to treatment, at a time after treatment when leaves that had been sprayed directly had very little effect on GPA. This suggests that the active ingredient of RH7988 is translocated to the top of the plant. This could be a beneficial characteristic of the insecticide since many aphids often alight on and prefer to feed on soft young foliage.

RH7988 is reported as being a highly selective insecticide (Murray *et al* 1988) which is not effective for the control of dipteran or lepidopteran insect pests ($LC_{50} > 25$ and 600 mg/litre respectively) and causes low mortality (<30%) of beneficial insects (*Apis mellifera*, *Hippodamia convergens*, *Stethorus punctum*, *Uga menoni*, *Endovum putleri* and *Pedobius fovea*). The recommended field concentration of RH7988 (0.2 g/litre) has been shown to cause 100% moribundity of both aphid species (Herman and Chapman 1989). This rate did not cause such a high moribundity in the natural enemy species tested indicating the insecticide is more selective for GPA and CA. These laboratory experiments have indicated the potential of RH7988 to be a selective insecticide for control of aphids in forage and vegetable brassica crops, but further field trials are required to confirm whether this insecticide could safely be included in integrated control programmes for aphid pests.

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