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Evaluation of aphicides for control of
rosy apple aphid 1997

Undertaken for APRC

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CONTENTS

Evaluation of aphicides for control of rosy apple aphid 1997

Summary

Eight insecticides were evaluated between May to June 1997 for control of rosy apple aphid (*Dysaphis plantaginea*) in two experiments in a commercial apple orchard (cvs. Fiesta and Jonagold) at Laddingford, Kent. Treatments consisted of a single foliar spray of heptenophos (Hostaquick, 935g ai ha^{-1}), chlorpyrifos (Dursban 4, 960g ai ha^{-1}), pirimicarb (Aphox, 210g ai ha^{-1}), HP9256 ('coded', 250g ai ha^{-1}), HP9256 ('coded', 375g ai ha^{-1}), triazamate (Aztec, 70g ai ha^{-1}), imidacloprid (Admire, 125g ai ha^{-1}) and pymetrozine (CGA 215944, 150g ai ha^{-1}), applied in a volume of 200 l ha^{-1}. Populations of rosy apple aphid were assessed 7 and 21 days after treatment.

In the first experiment, against an established infestation, populations of aphids decreased in all plots including the untreated control after treatment application, probably due to unfavourable weather. In the second experiment, in which the numbers of rosy apple aphid were increasing, the three insecticides Approved for use against this pest (pirimicarb (Aphox), chlorpyrifos (Dursban) and heptenophos (Hostaquick)) gave partial control. Imidacloprid (Admire), triazamate (Aztec) and HP9256 also gave significant reductions, at least as good as the standard products, and may be potential candidates for the control of rosy apple aphid. As in previous experiments pymetrozine (CGA217944) was ineffective. Further work is needed to evaluate optimal spray timing of imidacloprid, triazamate and HP9256.

Introduction

Rosy apple aphid, *Dysaphis plantaginea* (Passerini), is a key pest of apple (Alford, 1984). In the absence of effective control measures, severe damage commonly occurs in orchards. Infested leaves are curled severely. Occasionally leaves fall prematurly. Damaged shoots are also twisted and do not produce flower buds for the following year. Fruitlets remain small, waxy and misshapen, often having a rosy red colouration.

Dysaphis plantaginea has two hosts, plantain (*Plantago* spp.) and apple. Eggs are laid in bark crevices on apple in the autumn by oviparous offspring of migrant females returning from the summer host. The eggs hatch in spring at the green cluster to blossom growth stages. The aphids move to the undersides of rosette leaves. As the colonies develop, the distorted leaves provide protection for the aphids. Reproduction is parthenogenetic and numbers increase rapidly if conditions are favourable. The colonies increase in size and in numbers as aphids spread from initial foci. In a few weeks, whole branches may be infested severely, each colony having arisen from perhaps a single overwintered egg. By late May-June numerous colonies may be seen. In June-July, winged females develop and these migrate to plantain. However, colonies may persist on apple until late summer if new vegetative growth is present.

Rosy apple aphid is difficult to control with insecticides, especially after colonies have established. Natural enemies are not sufficiently effective at regulating populations at low enough levels to prevent damage. Contact-acting materials, such as chlorpyrifos (Dursban 4), are only effective fully before blossom. Systemic aphicides are preferable for controlling established colonies. If complete control is not achieved before bloom, infestations can develop during bloom and cause severe damage, especially if the blossom period is

protracted. Aphicides which are harmful to bees cannot be applied until petal fall. The systemic organophosphorus (OP) insecticide demeton-S-methyl (Metasystox) is effective and was relied on by growers for many years, but is no longer approved. The systemic OP dimethoate should not be used as it is harmful to the predatory mite *Typhlodromus pyri*. The only remaining systemic OP aphicide approved for use on apple in the UK is heptenophos (Hostaquick). This aphicide has short persistence and is classed as toxic to humans (Anon, 1997). UK apple growers have only limited experience of its use.

The carbamate insecticide pirimicarb, a partially systemic, fumigant and contact-acting aphicide of short persistence, is favoured currently for control of established infestations of rosy apple aphid in an IPM programme (Easterbrook *et al.*, 1985). It is partially selective and is not harmful to bees, or to predatory insects such as ladybirds, lacewings and hoverfly larvae (Anon, 1989). However, growers sometimes report disappointing results, especially in cool conditions.

In Italy and Switzerland, rosy apple aphid has developed resistance to insecticides including OPs and carbamates, and there are also reports of increasing difficulties in achieving control in The Netherlands (Waldner, 1996; Schaub, 1997). There is no evidence of resistance in the UK at present but if resistance were to develop, no alternative aphicides from other chemical groups are approved currently.

The introduction of fenoxycarb (Insegar) to control summer fruit tortrix moth may also lead to an increase in the numbers of rosy apple aphid, if the use of chlorpyrifos declines.

In 1996, field experiments funded by the APRC showed acceptable, although incomplete control of rosy apple aphid with pirimicarb and only a mediocre result with heptenophos and chlorpyrifos (Cross, 1996). Imidacloprid and buprofenzin gave significant but small reductions in aphid populations; tebufenpyrad and pymetrozine did not. As OP and carbamate insecticides are anti-cholinesterase compounds and are a significant health risk, a pest management strategy which does not rely on them is needed. In 1997 two experiments were conducted to look at the efficacy of a range of approved and experimental insecticides, with the aim of identifying promising new aphicides for control of rosy apple aphid. The results of these experiments are reported here.

Methods and Materials

The two experiments were done in a commercial orchard at West Pike Fish Farm, Laddingford, Kent on infested apple trees (cvs. Fiesta and Jonagold, 4.5 m x 3 m spacing). Treatments were single foliar sprays of eight aphicides, including heptenophos (Hostaquick), chlorpyrifos (Dursban 4) and pirimicarb (Aphox) as standards, and an untreated control (Table 1).

Experiment 1

Sprays were applied on 1 May 1997 in a volume of 200 l ha^{-1} using a SOLO 436 self-propelled air-assisted sprayer with eight (four per side) Albuz 210 hollow cone nozzles operated at 6 bar pressure. Only the 4 nozzles on one side of the sprayer were used. Both sides of the trees were sprayed. The sprays were applied between 12.30 and 14.52 hrs. The air temperature was approximately constant at 21□C. Conditions were bright with a slight westerly breeze. The windspeed was 1-2 ms^{-1}.

Experiment 2
Sprays were applied on 4 June 1997 in a volume of 200 l ha^{-1} using a SOLO 436 self-propelled air assisted sprayer with eight (four per side) Albuz 210 hollow cone nozzles operated at 7 bar pressure. As before, only four nozzles were used. The sprays were applied between 13.30 and 15.15 hrs. The air temperature ranged from 18 to 19□C. The weather conditions were fine and dry with a light north-easterly wind which was variable with an average windspeed of 2 ms^{-1}.

For both experiments a randomised complete block design with four replicates was used. The untreated control was doubly replicated in experiment 2. Plots consisted of four adjacent trees in a row, with plots arranged end-to-end in a row for each block. Blocks were individual rows separated by an unsprayed guard row.

Populations of rosy apple aphid were assessed on each tree at 7 and 21 days after each spray. The numbers of colonies on each tree, the numbers of colonies containing live rosy apple aphids, the numbers of damaged leaves and the numbers of leaves in each colony infested with live rosy apple aphid were recorded.

For statistical analysis, a Generalised Linear Model with binomial errors was used to give estimated means and approximate standard errors for the proportion of colonies and damaged leaves infested with live aphids.

Results

Experiment 1
All aphids were dead in 82% of colonies from untreated control plots seven days after the spray treatments were applied. Only 5.4 % of colonies contained living aphids by the 21 day assessment (Table 2). There were no statistically significant treatment differences in the percentage of colonies with live aphids. There was an effect of treatment on the percentage of damaged leaves containing live aphids (Table 3). This was only assessed at 21 days for this trial, due to the small numbers of damaged leaves at the 7 day assessment. Only two of the eight treatments (HP9256 at 375 g ai ha^{-1} and triazamate) gave a significant result.

Experiment 2
The untreated controls had high numbers of aphids at both assessment dates. After seven days, only chlorpyrifos significantly decreased the percentage of colonies with live aphids. The results for the percentage of damaged leaves infested with aphids were different on the same date, with heptenophos, pirimicarb and imidacloprid giving significant reductions at $p \square 0.05$, and triazamate being significant at $p \square 0.001$.

After 21 days, all treatments were effective, apart fom pymetrozine which had more infestations than the control. Pirimicarb and imidacloprid were most effective at decreasing the percentage of damaged leaves containing live aphids, giving significant reductions at $p \square 0.001$ and 0.01 respectively. Heptenophos, chlorpyrifos, HP9256 and triazamate gave significant reductions at $p \square 0.05$. There were significant reductions in the percentage of colonies infested with live aphids following treatment with chlorpyrifos, pirimicarb, HP9256, triazamate and imidacloprid ($p \square 0.001$) and heptenophos ($p \square 0.01$).

Discussion

The populations of rosy apple aphid were unexpectedly small and did not increase on the untreated plots in the first experiment, probably due to unfavourable weather conditions. The results of the second experiment validated the results of the 1996 experiment, and have identified potential new insecticides for controlling rosy apple aphid. As expected, the three approved insecticides, heptenophos, chlorpyrifos and pirimicarb, gave partial control of aphids. These results have confirmed the results of Cross (1996), showing imidacloprid to be effective. Two other insecticides were identified as effective control agents: triazamate and HP9256. As in the 1996 experiment, pymetrozine was ineffective and resulted in higher levels of infestation. It is important to repeat these experiments to validate these results and to generate data for registration purposes. It would also be valuable to evaluate the effectiveness of Neemazal TS, an extract of the neem tree, as this product has shown potential for controlling rosy apple aphid in Germany (Kienzle, Schulz and Zebitz, 1997; Vogt, Händel and Viñula, 1997) and Switzerland (Zuber, 1997). Neem-based products are suitable for inclusion in Integrated Pest Management programmes as they are relatively benign to aphid predators and parasitoids (Lowery & Isman, 1994; 1995).

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Table 1 Treatments

Treatment number	Active ingredient and formulation	Product	Dose	
			product ha^{-1}	g ai ha^{-1}
1	untreated	-	-	-
2	heptenophos 550 g l^{-1} EC	Hostaquick	1.7 l	935
3	chlorpyrifos 480 g l^{-1} EC	Dursban 4	2 l	960
4	pirimicarb 50 % w/w SG	Aphox	420 g	210
5*	HP9256 ai	HP9256	250 g ai	250
6	HP9256 ai	HP9256	375 g ai	375
7	triazamate 140g l^{-1} EW	Aztec	500 ml	70
8	imidacloprid 70 % w/w WS	Admire	178 g	125
9	pymetrozine 25 % w/w WP	CGA215944	600 g	150

* treatment 5 was not included in Experiment 2.

Table 2 **Mean percentage of colonies with live aphids (x) and approximate standard error (se) 7 and 21 days after application of treatments.**

Treatment number (see Table 1)		Experiment 1 % colonies with live aphids				Experiment 2 % colonies with live aphids			
		8 May		22 May		11 June		24 June	
		x	se	x	se	x	se	x	se
1	untreated	17.9	6.4	5.4	5.1	74.7	8.0	64.8	5.5
2	heptenophos	45.2	16.0	10.6	11.8	68.2	13.5	35.6 **	8.9
3	chlorpyrifos	18.4	7.8	25.6	13.3	19.9 *	11.7	27.8 ***	7.9
4	pirimicarb	20.8	10.5	13.5	14.4	51.9	16.1	15.3 ***	7.8
5	HP9256	6.6	8.0	22.3	15.9	-	-	-	-
6	HP9256	22.6	9.4	21.6	12.9	50.5	10.6	17.0 ***	11.5
7	triazamate	22.8	7.9	32.4	11.7	54.4	14.7	11.3 ***	8.6
8	imidacloprid	25.1	11.0	37.9	15.4	59.4	13.9	8.6 ***	6.6
9	pymetrozine	23.8	9.4	22.3	12.6	55.0	12.1	86.0	6.0

s.e.d. = $\sqrt{(se_1^2 + se_2^2)}$. $t = x_1 - x_2$ / s.e.d with 23 d.f. for experiment 1 and 25 d.f. for experiment 2.
*, **, *** significantly less than control for P □ 0.05, 0.01 & 0.001 respectively.

Table 3 **Mean percentage of damaged leaves with live aphids per tree (x) and approximate standard error (se) 7 and 21 days after application of treatments.**

Treatment number (see Table 1)		Experiment 1			Experiment 2			
		Percentage of damaged leaves with live aphids			Percentage of damaged leaves with live aphids			
		8 May not assessed	22 May		11 June		24 June	
			x	se	x	se	x	se
1	untreated	-	49.5	13.8	87.4	3.9	68.5	5.7
2	heptenophos	-	17.0	17.0	53.9*	11.8	40.8*	11.6
3	chlorpyrifos	-	57.9	15.2	69.1	10.5	38.5*	10.2
4	pirimicarb	-	51.7	16.3	59.0*	10.8	18.7***	9.5
5	HP9256	-	25.1	15.5	-	-	-	-
6	HP9256	-	8.4*	9.8	75.0	10.5	28.5*	17.2
7	triazamate	-	6.0*	11.0	31.4***	10.8	24.0*	15.8
8	imidacloprid	-	32.8	18.7	50.0*	14.9	18.7**	12.6
9	pymetrozine	-	43.1	14.4	94.5	4.0	92.3	4.3

s.e.d. = $\sqrt{(se_1^2 + se_2^2)}$. $t = x_1 - x_2$ / s.e.d with 23 d.f. for trial 1 and 25 d.f. for trial 2.
*, **, *** significantly less than control for P □ 0.05, 0.01 & 0.001 respectively.