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Systemic granular insecticides for protection of lucerne seedlings from the aphids Therioaphis trifolii (Monell) f. maculata and Acyrthosiphon kondoi Shinji

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Summary

Three trials were conducted to investigate the use of granular insecticides, applied at planting, to provide protection from the aphids *Therioaphis trifolii* (Monell) f. *maculata* and *Acyrthosiphon kondoi* Shinji during establishment of lucerne stands.

Minimum dosages of disulfoton, thiofanox and aldicarb applied in the planting drills to provide protection from both aphid species were 250, 500 and 500 g ha^{-1} a.c., respectively. Terbufos, carbofuran and phorate could have potential for use, but fensulfothion and protriazophos at 2 kg ha^{-1} a.c. when broadcast were less effective and acephate 2 kg ha^{-1} a.c. was ineffective.

1. INTRODUCTION

Spotted alfalfa aphid (SAA), *Therioaphis trifolii* (Monell) f. *maculata* and blue-green aphid (BGA) *Acyrthosiphon kondoi* Shinji can cause severe stand reductions in seedling lucerne (Dobson and Watts 1957; Reynolds, Fukuto, Metcalf and March 1957; Wynne-Williams and Burnett 1977).

The frequent applications of short lived insecticide sprays that could be necessary under heavy aphid invasion pressure are undesirable because of the potential crop damage from ground equipment or the high cost of aerial applications. Therefore, the potential of systemic granular insecticides applied at planting to provide protection from the aphids during stand establishment warranted investigation.

2. MATERIALS AND METHODS

Three trials were conducted at Gatton using the aphid susceptible cultivar, Hunter River. Planting dates were 23 May 1977, 20 April 1978 and 17 July 1978.

Trial 1 was a 10 × 3 randomised block design with plot size of 10 m^2. The seed (12 kg ha^{-1}) and granules (2 kg ha^{-1} a.c.) were broadcast separately by hand and raked into the soil surface. The treatments are shown in the tables of results (Tables 1 and 2).

In Trials 2 and 3, using 10 × 3 randomised blocks layout with plot size of 10 rows at 175 mm spacing × 20 m, the insecticides which gave reasonable results in Trial 1, namely thiofanox, aldicarb and disulfoton, were each used at dosages of 150, 250 and 500 g ha^{-1} a.c. The granules and seed (10 kg ha^{-1}) were distributed together through a cone planter into the drill.

Table 1. Lucerne aphids : granular insecticide trials. Trial 1 relative assessments of aphid populations at various days after planting

Days after planting		28		42		56				81			
Treatment (2 kg ha^{-1} a.c.)		Apterous SAA (10 plants)		Apterous SAA (10 leaves)		Apterous SAA (10 leaves)		Apterous BGA (10 leaves)		Total SAA (10 leaves)		Total BGA (10 terminals)	
		Transformation* mean	Equivalent mean	Transformation* mean	Equivalent mean	Transformation* mean	Equivalent mean	Transformation* mean	Equivalent mean	Transformation† mean	Equivalent mean	Transformation† mean	Equivalent mean
Acephate		1.754	2.58	3.749	13.56	6.794	45.7	0.996	0.49	12.11	147	12.25	150
Aldicarb		0.742	0.05	0.742	0.05	1.781	2.7	0.707	0.00	6.13	38	12.18	148
Carbofuran		1.075	0.66	1.357	1.34	2.072	3.8	0.952	0.41	7.47	56	11.60	135
Disulfoton		0.707	0.00	0.742	0.05	1.186	0.9	0.765	0.09	6.70	45	10.76	116
Fensulfothion		1.531	1.84	2.707	6.83	4.520	19.9	1.185	0.90	10.58	112	11.79	139
Phorate		0.742	0.05	1.720	0.87	2.284	4.7	0.869	0.25	7.83	61	12.04	145
Protriazophos		0.811	0.16	1.821	2.81	4.666	21.3	0.834	0.20	11.28	127	11.95	143
Terbufos		0.742	0.05	0.843	0.21	1.845	2.9	0.742	0.05	8.14	66	11.64	135
Thiofanox		0.765	0.09	0.707	0.00	0.927	0.4	0.707	0.00	4.30	18	11.61	135
Untreated		2.590	6.21	3.574	12.27	6.344	39.8	1.239	1.04	11.89	141	12.16	148
l.s.d.	5%	0.657		0.949		1.627		0.296		2.70		n.s.d.	
	1%	0.900		1.300		2.230		0.406		3.71			

* $\sqrt{x + 0.5}$ transformation applied to aphid counts per 10 plants/leaves.

† $\sqrt{x}$ transformation applied to mean of rating category per leaf/terminal.

Several methods of population assessment were used. In Trials 1 and 2, aphid numbers were assessed *in situ*. At the first assessment in Trial 1, five groups of 10 plants per plot were examined. At the next two assessments, leaves were examined in five groups of 10 per plot and, at the final assessment, a rating system was used in which populations of SAA on 20 leaves and BGA on 20 terminals per plot were categorised as no aphid present (value 0), alatae only (value 1), less than 10 aphids per leaf/terminal (value 5) or more than 10 aphids per leaf/terminal (value 15). In Trial 2, 10 groups of five lower leaves per plot were examined throughout. In Trial 3, plants with the aphids—50 plants per plot at the first assessment and 20 plants per plot at the second—were taken from the field into the laboratory. The aphids were separated from the plant material by washing in warm water and then counted. At all assessments, except when the rating system was used, numbers of apterae and alatae of both SAA and BGA were recorded.

Seedling mortality due to aphid attack was observed in Trial 1 only. Estimates of seedling mortality were made on two occasions—99 days and 106 days after planting. Negligible mortality occurred in Trials 2 and 3.

3. RESULTS

Numbers of alatae of both SAA and BGA were low throughout all trials (less than five per sampling unit). These counts, in the early stages of each trial at least, were intended as a measure of aphid invasion pressure and are not presented.

In Trial 1 thiofanox, aldicarb and disulfoton were effective in maintaining low numbers of SAA apterae for up to 81 days from planting (Table 1). Acephate treatment was ineffective. Although numbers were small, thiofanox, aldicarb, terbufos and disulfoton provided the most effective suppression of BGA when they appeared in the trial 56 days after planting. However, at the 81 days count BGA populations had increased throughout all treatments even where control of SAA was maintained. High populations of both SAA and BGA eventually caused 100% seedling mortality 106 days after planting in the untreated and the acephate, fensulfothion and protriazophos treated plots (Table 2). Where aphid populations were suppressed following treatments with thiofanox, aldicarb and disulfoton, mortality was significantly ($P<0.01$) less than in all other treatments.

Table 2. Lucerne aphids : granular insecticide trials. Trial 1 percentage seedling mortalities at 99 and 106 days after planting

Days after planting		99		106	
Treatment (2 kg ha^{-1} a.c.)		Transformation* mean	Equivalent mean	Transformation* mean	Equivalent mean
Acephate		1.57	100	1.57	100
Aldicarb		0.29	8.2	0.52	24.9
Carbofuran		0.85	56.2	1.15	83.2
Disulfoton		0.35	11.6	0.66	38.0
Fensulfothion		1.15	83.4	1.57	100
Phorate		0.94	65.1	1.22	88.4
Protriazophos		1.36	95.5	1.57	100
Terbufos		0.61	32.8	1.04	74.6
Thiofanox		0.23	5.0	0.35	11.6
Untreated		1.50	99.4	1.57	100
l.s.d.	5%	0.23		0.16	
	1%	0.32		0.21	

* Arcs in transformation applied to plot assessments.

All treatments in Trial 2 with the exception of aldicarb at 150 g ha^{-1} a.c. suppressed numbers of SAA apterae at all assessments (Table 3) up to 60 days after planting.

Table 3. Lucerne aphids : granular insecticides trials. Trial 2 numbers of apterous SAA per 5 leaves at various days after planting

Days after planting		34		43		49		60	
Insecticide	g ha^{-1} a.c.	Transformation* mean	Equivalent mean	Transformation* mean	Equivalent mean	Transformation* mean	Equivalent mean	Transformation* mean	Equivalent mean
Thiofanox	150	1.875	3.0	3.871	14.5	4.184	17.0	3.366	10.8
	250	1.771	2.6	3.105	9.1	4.072	16.1	2.788	7.3
	500	1.115	0.7	1.435	1.6	1.916	3.2	2.158	4.2
Aldicarb	150	2.627	6.4	5.138	25.9	6.005	35.6	5.182	26.4
	250	1.989	3.5	3.610	12.5	5.116	25.7	4.643	21.1
	500	1.204	1.0	2.368	5.1	3.679	13.0	3.231	9.9
Disulfoton	150	1.842	2.9	4.214	17.3	5.458	29.3	4.520	19.9
	250	1.756	2.6	3.282	10.3	4.521	19.9	3.862	14.4
	500	0.900	0.3	2.082	3.8	2.521	5.8	1.463	1.6
Untreated	..	2.953	8.2	6.438	40.9	8.075	64.7	5.939	34.8
l.s.d. 5%		0.519		0.839		0.914		0.887	
1%		0.711		1.150		1.252		1.216	

* $\sqrt{x + 0.5}$ transformation applied to aphid counts per 5 leaves.

Populations of SAA in Trial 3 were lower than in previous trials. However, all treatments except aldicarb at 150 g ha^{-1} a.c. maintained numbers of SAA apterae at lower ($P<0.01$) levels than in untreated plots (Table 4). Although all treatments suppressed populations of BGA apterae up to 42 days after planting, the superior treatments were thiofanox at 500 g ha^{-1} a.c., aldicarb at 500 g ha^{-1} a.c. and disulfoton at 500 and 250 g ha^{-1} a.c.

Table 4. Lucerne aphids : granular insecticide trials. Trial 3 numbers of apterous SAA and BGA per 10 plants at 28 and 42 days after planting

Days after planting		28				42			
		SAA		BGA		SAA		BGA	
Insecticide	g ha^{-1} a.c.	Transformation* mean	Equivalent mean	Transformation* mean	Equivalent mean	Transformation* mean	Equivalent mean	Transformation* mean	Equivalent mean
Thiofanox	150	0.788	0.12	1.939	3.3	1.096	0.70	9.338	86.7
	250	n.a.	0.00	1.912	3.2	0.943	0.39	9.421	88.3
	500	0.750	0.06	1.191	0.9	n.a.	0.00	6.198	37.9
Aldicarb	150	0.851	0.22	2.427	5.4	2.345	5.00	9.971	98.9
	250	n.a.	0.00	1.560	1.9	1.452	1.61	10.764	115.4
	500	n.a.	0.00	0.895	0.3	n.a.	0.00	5.396	28.6
Disulfoton	150	0.750	0.06	2.211	4.4	1.221	0.99	10.954	119.5
	250	0.750	0.06	1.042	0.6	1.179	0.89	6.629	43.4
	500	n.a.	0.00	0.868	0.3	n.a.	0.00	6.035	35.9
Untreated	..	1.841	2.89	4.218	17.3	3.878	14.54	15.286	233.2
l.s.d. 5%		0.509		1.038		1.415		3.572	
1%		0.724		1.422		1.984		4.894	

* $\sqrt{x + 0.5}$ transformation applied to aphid counts per 10 plants.
n.a.—not included in analysis.

4. DISCUSSION

Aphid infestations during the cotyledon and first unifoliate leaf stage of lucerne growth are the most devastating although susceptibility to SAA extends to the formation of fifth trifoliate leaf (Reynolds *et al.* 1957; Wynne-Williams and Burnett 1977). Early infestations sufficient to cause seedling mortality did not occur in any of these trials and the aphid populations attained up to 6 weeks after planting were insufficient to cause noticeable seedling mortality.

Most insecticides tested provided significant suppression of SAA populations throughout the trials. Populations of BGA were not so effectively controlled. None of the treatments in Trial 1 suppressed BGA populations at the final assessment. In Trial 3, although populations in all treatments were significantly less than in untreated plots, they were comparatively high in some treatments.

The seedling mortalities experienced 15 weeks after planting Trial 1 should not occur in commercial practice as, at this stage of growth, control with normal spraying techniques is feasible. Also, with suitable monitoring, sprays would be applied before the high populations necessary to cause plant death had developed.

The three most effective insecticides in Trial 1 were thiofanox, aldicarb and disulfoton. Terbufos, carbofuran and phorate showed some potential for use in this application while fensulfothion and protriazophos were less effective. Acephate was ineffective. In the dosage trials, only aldicarb at 50 g ha^{-1} a.c. was ineffective against SAA while the best treatments (not significantly different from one another) against both species were thiofanox at 500 g ha^{-1} a.c., aldicarb at 500 g ha^{-1} a.c. and disulfoton at 500 and 250 g ha^{-1} a.c.

These trials do not directly define the effects of systemic insecticides applied at planting on an early influx of aphids. However, considering the time period during which control has been exercised, and the distribution and dissipation of insecticides in plants (Reynolds *et al.* 1957), satisfactory protection of young seedlings should be provided.

The earlier breakdown in control of BGA can be explained also by insecticide distribution in plants. SAA tends to colonise lower leaves (Davis 1957) where insecticide accumulation is concentrated, while BGA colonises plant apices (Kain, Esson, Holland and Atkinson 1976) where the insecticide is more diluted as the plants grow.

5. CONCLUSIONS

Dosages of 250, 500 and 500 g ha^{-1} a.c. of disulfoton, thiofanox and aldicarb respectively applied as granules in drills with lucerne seed are recommended where control of both SAA and BGA is required during seedling establishment.

The granular insecticides terbufos, carbofuran and phorate could have a potential for use.

Protriazophos and fensulfothion were less effective and acephate was ineffective when broadcast at 2 kg ha^{-1} a.c.

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