INSECTICIDAL CONTROL OF ADULT ARGENTINE STEM WEEVIL: A REVIEW AND BIOASSAY EVALUATIONS

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SUMMARY

Previous studies on the chemical control of Argentine stem weevil *(Listronotus bonariensis)* are reviewed. The activity of 24 chemicals against adult weevils were tested in bioassays. The most effective chemicals were bendiocarb, carbofuran, methiocarb, oxamyl, azinphos-methyl, chlorpyrifos, isazophos, phosmet and deltamethrin.

INTRODUCTION

Argentine stem weevil is a serious pest of pasture grasses throughout New Zealand and has been estimated to cause losses in excess of $100 million/annum (Pottinger and Barker 1983). Despite the recognition of the pest status of stem weevil, economic damage thresholds have not been established. There is a reluctance by farmers to apply chemical controls because of cost.

Chemical control of the adult stage prior to oviposition, and the early larval stages provide opportunities for the prevention of pasture damage. The lack of cheap, easy to apply and effective chemical controls, however, represents a major problem. This paper briefly reviews previous insecticidal work and gives bioassay results for foliar applied insecticides against adult weevils.

Previous isecticidal work

Lowe (1956, 1958) found DDT and lindane were effective against stem weevil adults in brassicas. Kelsey (1958, 1959) discussed the possibility of using lindane and DDT for control of stem weevil, and recommended that lindane should be applied against each generation before the onset of egg laying. Pottinger (1961) pointed out that large flights could result in rapid reinfestation of fields recently treated with DDT and subsequently stem weevil larvae and pupae could be recovered from the soil.

Neilson (1964) tested in small plots vamidothion, dimethoate, demeton-s-methyl, thiometon and ethion, each applied at 0.5 kg ai/ha and found that all were ineffective against overwintering adults and early larvae. Similarly, he tested granular formulations of DDT, diazinon and heptachlor. All failed to show any effectiveness although rates of application ranged from 1.0 to 4.0 kg ai/ha. Isobenzan (at 0.5 kg ai/ha) showed some activity when applied in granular form, but this material was never widely used and was withdrawn from use. He also laboratory screened a number of insecticides of which diazinon, lindane, demeton-s-methyl, dieldrin, isobenzan and phorate were most toxic to Argentine stem weevil. Later, Nielson (1966) field-tested nine organo-phosphates applied as sprays against adults. Diazinon and methidathion were effective when applied at 2.2 kg ai/ha in June. Buchanan (1966) topically tested a number of insecticides for activity on adults and found fensulfothion and diazinon the most active. The systemic activity of 14 insecticides applied against the larval stages on wheat was evaluated by Bahadur (1970). Only mevinphos had promise. Forgie (1974) cited unpublished Ivon Watkins-Dow laboratory results in which chlorpyrifos was four to five times more toxic to adults than diazinon. Accordingly, he tested the material in the field on Tama and Ariki ryegrass seed crops in October at the rates of 0.5 and 1.0 kg ai/ha and obtained a reduction in tiller damage and an increase in yield at both rates. He pointed out that if the pattern of incoming flights could be rationalised, even more effective use of chlorpyrifos could be made in protection of crops. Welsh *et al* (1974) tested seven insecticides against larval populations in Tama and Manawa ryegrass seed crops in October and November and found

that oxamyl at 0.5 kg ai/ha and 1.0 kg ai/ha significantly reduced the levels of infestation. They pointed out that oxamyl, being a foliar systemic insecticide was probably more effective than the granular formulation of carbofuran and phorate as the dry soil conditions which typify Canterbury were probably insufficient to allow uniform uptake by the plants. MacKay and Rowe (1974) showed that carbofuran (at 1 kg ai/ha) and phorate (at 1 kg ai/ha) drilled with the seed significantly reduced larval damage in emerging maize. Similar results were obtained by Watson and Wrenn (1978) using isazophos (2 kg ai/ha) and carbofuran (1.7 kg ai/ha). Fensulfothion (2 kg ai/ha) was not effective. Trought (1976) demonstrated that summer sown grass treated with phorate or carbofuran (1-2 kg ai/ha) was protected from adult feeding damage and oviposition.

Only oxamyl and chlorpyrifos are registered for control of stem weevil in established pastures against larvae and adults respectively. Carbofuran can be drilled with seed to provide seedling grasses. Oxamyl is recommended for application at 0.48 kg ai/ha. This costs $50/ha. Chlorpyrifos at the recommended rate of 0.6 kg ai/ha costs $34/ha. The objective of the insecticide screening was to find chemcials with activity and persistence equal to or better than oxamyl and chlorpyrifos, but at reduced cost.

In experimental situations in grazed pastures, researchers at Ruakura currently use foliar applications of oxamyl applied at intervals of 10-14 days from early spring to maintain a stem weevil-free area. Oxamyl works quickly against both adult and larval stem weevils and has a stock withholding period of 7 days. Prestidge *et al* (1983) found that for adequate control of larvae, a minimum of two oxamyl applications were required in summer against the second generation.

METHODS

A bioassay technique was used to assess the biological activity of 24 insecticides. Two trials were conducted. All products were sprayed onto 2.5 x 8.0 m perennial ryegrass *(Lolium perenne* cv. Nui*)*/white clover *(Trifolium repens* cv. Huia*)* plots. Applications were made with a hand-held 2.4 m boom fitted with Spraying Systems flat fan nozzles (No. 730154) operated at 210 kPa and delivering 300 litres/ha from a pressurised mistifier knapsack sprayer. Plots were replicated twice. Three foliage samples were clipped from each plot at 1, 2, 5, 8, 12 and 21 days after spraying. A 5 g wet weight subsample of the foliage was placed in a small jar and 10 weevils added. The jars were kept at room temperature for 48 h and assessment of weevil mortality made.

A field assessment of insecticide activity was made on day 2 in trial 2. Weevil numbers were estimated by sweeping with a 300 mm diameter net along two 5 m swaths in each plot 30-60 minutes after sunset.

All chemicals were applied at 1.0 kg ai/ha in trial 1 with the exception of the synthetic pyrethroids which were applied at 0.1 kg ai/ha.

Chemicals, found active in the laboratory bioassays in trial 1, were applied in trial 2 at 0.5 and 0.25 kg/ha, with the exception of the synthetic pyrethroids which were applied at 0.050 and 0.025 kg ai/ha. Chlorpyrifos was used as a standard for comparison with the other chemicals, as it is the only insecticide registered to control adult stem weevils in pasture.

Significant differences between results from treated, untreated and chlorpyrifos plots (0.5 ai kg/ha) were determined using Dunnett's one-sided test for data on a logit scale. Estimates of the day at which mortality declined to 50% were obtained by logit analysis and treatment differences in sweep net catches by analysis of variance of log transformed data.

RESULTS

The bioassay tests in trial 1 showed bendiocarb, carbofuran, methiocarb, oxamyl, azinphosmethyl, chlorpyrifos, isazophos, phosmet and deltamethrin achieved more than 90% mortality on day 1 (Table 1). All of these chemicals had sufficient residual activity to effect 50% mortality on day 3. Isazophos and deltamethrin exhibited the greatest residual activity and achieved in excess of 50% mortality for 9.9 and 6.4 days respectively.

In trial 2 (Table 2), where reduced rates were evaluated, activity and persistence were generally reduced. Carbofuran (0.5 kg ai/ha), oxamyl 0.5 kg ai/ha), isazophos (0.05 and 0.25 kg ai/ha), phosmet (0.5 kg ai/ha) and deltamethrin (0.05 kg ai/ha) effected more than

TABLE 1: Trial 1. The biological activity and persistence of insecticides as determined by bioassay tests for adult Argentine stem weevil on treated foliage..

Chemical	Rate/ Trade name/ formulation	%bioassay mortality day 1	Estimated day after spraying at which bioassay mortality reached 50%
Carbamates	1.0 kg ai/ha		
bendiocarb	Garvox 80 WP	95*	3.3
carbaryl	Carbaryl 80 WP	0+	1
carbofuran	Furadan 75 WP	100*	4.1
methiocarb	Mesurol 75 WP	100*	4.2
oxamyl	Vydate 24 NAC	100*	4.6
pirimicarb	Pirimor 50 DG	2+	1
Organophosphates	1.0 kg ai/ha		
acephate	Orthene 75 WP	54*+	1
azinphosmethyl	Gusathion M 50	100*	4.4
chlorpyrifos	Lorsban 40 EC	100*	3.3
demeton-s-methyl	Metasystox 30 EC	2+	1
diazinon	Dyzol 80 EC	37*+	1
dimethoate	Rogor 20 WP	34+	1
fenitrothion	Caterkil 60 EC	54*+	1.4
isazophos	Miral 50 EC	100*	9.9
maldison	Maldison 50 EC	3+	1
omethoate	folimat 58 EC	33*+	1
phosmet	Imidan 75 WP	96*	3.6
thiometon	Ekatin 25 EC	2+	1
Organochlorines	1.0 kg ai/ha		
endosulfan	Thiodan 35 EC	0+	1
lindane	Lindane 50 WP	46*+	1
Pyrethroids	0.1 kg ai/ha		
cypermethrin	Ripcord 20 EC	52*+	1.2
deltamethrin	Decis 2.5 EC	93*	6.4
fenvalerate	Sumicidin 10 EC	32*+	1
permethrin	Ambush 50 EC	40*+	1
Untreated		0+	21

* Diff from untreated $P < 0.05$ SEM 0.72

\+ Diff from chlorpyrifos $P < 0.05$

70% mortality in the bioassay on day 1. Only isazophos, phosmet and deltamethrin effected more than 50% mortality after 3 days.

As mortality remained below 2% it is impossible to estimate the time at which 50% mortality of the stem weevil adults would have occurred in the non-insecticide treatments.

Sweep net sampling of the field plots in trial 2 (Table 2) suggested that the bioassays were a good indication of the field activity of the chemicals (% field mortality $= 25.92 + 0.78x$(% mort. day 1), $r = 0.84$, $P = < 0.001$).

TABLE 2: Trial 2. The biological activity and persistence of insecticides as determined by bioassay tests and sweep net catches for adult Argentine stem weevil on treated foliage.

Chemical	Rate kg ai/ha	%bioassay mortality day 1	Estimate day after spraying at which bioassay mortality reached 50%	%reduction in field population
Carbamates				
bendiocarb	0.50	28+	<1	47
	0.25	7+	<1	26
carbofuran	0.50	92*	2.3	88
	0.25	33*+	<1	69
methiocarb	0.50	56*	1.1	73
	0.25	20+	<1	76
oxamyl	0.50	76*	1.6	88
	0.25	47*	<1	43
Organophosphates				
azinphosmethyl	0.50	46*	<1	76
	0.25	25+	<1	39
chlorpyrifos	0.50	66*	1.2	94
	0.25	9+	<1	73
fenitrothion	0.50	3+	<1	8
	0.25	2+	<1	6
isazophos	0.50	100*	4.1	98
	0.25	100*	2.6	94
phosmet	0.50	76*	3.2	73
	0.25	33*+	<1	45
Pyrethroids				
deltamethrin	0.050	88*	6.6	94
	0.025	66*	2.8	86
untreated	-	2+	21	49 weevils/ 20 m sweep

* Diff. from untreated $P < 0.05$ SEM 1.46 LSR 5% 2.74
\+ Diff. from chlorpyrifos $P < 0.05$

DISCUSSION AND CONCLUSIONS

As adult stem weevils live on the surface of the ground or in the crowns of grasses, and move onto foliage to feed, lay eggs and initiate flight, insecticides should be formulated and applied to take advantage of these phenomena. All of the chemicals evaluated in these preliminary trials were applied as sprays. The results clearly show that the level of mortality and persistence was related to the rate of each chemical applied.

All three chemicals, oxamyl, carbofuran and chlorpyrifos, registered for control of Argentine stem weevil were effective at 1 kg ai/ha against adults. Oxamyl and chlorpyrifos were not as effective as carbofuran when applied at 0.5 kg ai/ha, and all were ineffective when applied at 0.25 kg ai/ha.

Comparison with chlorpyrifos when applied at lower rates indicates that carbofuran, isazophos, oxamyl, phosmet (all at 0.5 kg ai/ha) and deltamethrin (0.025 kg ai/ha) all gave equivalent or better control for longer periods. At current prices, phosmet ($20 at 0.5 kg ai/ha) and isazophos ($12 at 0.25 kg ai/ha) are cost competitive with chlorpyrifos ($34 at 0.6 kg ai/ha). Carbofuran is effective when applied at 0.5 kg ai/ha (cost $24) but unfortunately,

surface applications are not permitted on pasture. As a consequence, registration for contact use against adult stem weevils is unlikely in the future. Azinphos methyl is effective at 1 kg ai/ha at a cost of $35. Both oxamyl ($50 at 0.48 kg ai/ha) and methiocarb ($80 at 1 kg ai/ha) are not cost competitive on the basis of this preliminary screening trial.

In view of their toxicity to weevils, persistence, use against other pasture pests, and cost, isazophos, phosmet and deltamethrin show particular promise as alternatives to chlorpyrifos, the current recommended control for adult stem weevils.

The screening trials reported in this paper have shown that a large number of insecticides are toxic to Argentine stem weevil. Earlier screening trials were not so successful. Considerable research including field trials will be required, however, to ensure registration of these alternatives for use in pasture systems.

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