RESIDUAL EFFECTS OF CONTROLLED RELEASE CHLORPYRIFOS AGAINST GRASS GRUB LARVAE

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SUMMARY

Conventional granules containing fensulfothion 50 g/kg used at fensulfothion 1.1 kg/ha were shown in four field trials to control grass grub (*Costelytra zealandica*) for a few months. Controlled release granules containing chlorpyrifos 140 g/kg used at chlorpyrifos 1.96 kg/ha were shown in the same field trials to control grass grub for up to 2 years. The fourth field trial showed that a chlorpyrifos 100 g/kg controlled release granular formulation gave control of grass grub as good as chlorpyrifos 140 g/kg controlled release granular formulation.

INTRODUCTION

Four phases in the evolution of control of grass grub (*Costelytra zealandica*) and other pasture pests in New Zealand have been recognised (Pottinger and Wrenn 1988). These are: (a) Pre 1950; non-insecticidal curative, preventative and supplementary (b) 1951-1968; preventative insecticidal control with organochlorines when up to a third of the farm was treated with DDT (c) 1968-1978; curative insecticidal control with carbamates and organophosphates which are less persistent and do not accumulate in ecosystems like DDT (d) 1978 — present; preventative and curative Integrated Pest Management with optimisation of use of natural factors and insecticidal options.

The current range of insecticidal options for grass grub including conventional granules of fensulfothion, diazinon, isazophos and lindane (Barker 1987) have had their characteristics as options identified (East *et al* 1981; East 1984). The organophosphates are residually active against grass grub for only a few months. Lindane gives longer action but has been deregistered for agricultural use in New Zealand.

The suSCon controlled release granular technology described by McGuffog *et al* (1984), which makes it possible for organophosphate and carbamate formulations to be designed for a predetermined period of insecticidal action, suggested that chlorpyrifos might be formulated to give over 1 year's residual activity against grass grub. The observations of Hitchcock *et al* (1984) confirmed this possibility by recording high mortalities of third instar cane grub (*Lepidiota frenchi*) for 1, 2 and 3 years by varying formulation of chlorpyrifos and soil dosage.

Field trials began in 1985 and four trials (1986-1989) investigating the residual effectiveness of chlorpyrifos controlled release granules (CRG) against grass grub are reported here.

METHOD

All field trials were conducted with randomised block design, the first with four replicates of 3 m x 20 m plots and the others with five replicates and 10 m x 10 m plots.

The controlled release granular (CRG) formulations used chlorpyrifos at 140 g/kg (suSCon Blue) in 0.6 mm diameter granules (Trial 1 only) and in 1 mm diameter granules in all trials. In Trial 4, 1 mm diameter granules containing chlorpyrifos 100 g/kg (suSCon Green) were also applied. Conventional fensulfothion granules (Dasanit 5G) were used in all trials and conventional phorate granules (Phorate 20G) and Proc. 43rd N.Z. Weed and Pest Control Conf. 1990: 343-346

terbufos granules (Counter 20G) were used in the first trial. Trial details, including rates of application and trial locations, are given in Tables 1-4.

In each trial granules were direct drilled about 2 cm deep with grass seed during pasture renovation. This was completed on 13 May 1987 in the first trial, on 3 November 1987 in the second and third trial and on 26 October 1988 in the fourth trial.

The residual effects of controlled release chlorpyrifos against grass grub were assessed by soil bioassay in all trials and by monitoring larval field densities in all trials except the first. For bioassay, soil samples were taken to a depth of 5 cm over drill rows using eight 5 cm diameter soil cores per plot. Foliage was lightly clipped from the soil surface and discarded. The soil from each plot was diced with a knife, crumbled and thoroughly mixed, divided and placed into two 7.5 cm x 8 cm deep plastic pots. The soil was lightly compressed and eight larvae added to each pot. Only healthy grubs from an untreated area were used. Grubs that had not buried themselves within 2 hours were discarded and replaced with new grubs. Each pot was covered by a petri dish to prevent evaporation of moisture from the soil. After 2 weeks the grass grubs were sorted from the soil and a reburial test was used to determine mortality. The bioassay was conducted in ambient conditions in a shaded screenhouse. Larval field densities were determined by taking 12-25, 10 cm diameter, soil cores per plot and handsorting for larvae.

Analysis of the bioassay results was by logits and the field larval densities by analysis of variance using a $\log_e(x + 1)$ transformation and separating means by Least Significant Difference.

RESULTS AND DISCUSSION

In Trial 1 bioassays fensulfothion gave greater mortality of grass grub 1 month after treatment than did phorate or terbufos (Table 1). Chlorpyrifos CRG also gave good control 1 month after treatment but not as high as the fensulfothion treatment. At 7 months after treatment the fensulfothion granules had ceased to exert effective control whereas all rates of chlorpyrifos CRG were giving sustained activity against grass grub. This continued to 19 months after treatment with the highest rates of chlorpyrifos CRG but by 23 months after treatment activity had ceased against third instar larvae. The 1 mm diameter chlorpyrifos CRG appeared to be more effective than the 0.6 mm diameter granules particularly against third instars at 12 months after treatment.

The bioassays in Trial 2 (Table 2) and Trial 3 (data not presented) confirmed the observations made in Trial 1 with residual activity of chlorpyrifos CRG still strong at 16 months after treatment but much less so at 27 months after treatment. The field trials

TABLE 1: Trial 1: Residual effectiveness against grass grub larvae in bioassays of soil from renovated pasture treated with drilled applications of insecticides in May 1987 at Rolleston, Canterbury.

Treatment	Rate kg ai/ha	% mortality ¹				
		3rd instar 1 MAT	1st instar 7 MAT	3rd instar 12 MAT	1st instar 19 MAT	3rd instar 23 MAT
untreated		17(7)	6(4)	25(6)	17(8)	8(3)
chlorpyrifos CRG ²	1.96	72(9)	100(0)	77(6)	77(8)	12(3)
chlorpyrifos CRG ³	0.49	31(9)	100(0)	25(6)	27(9)	—
chlorpyrifos CRG ³	0.98	78(8)	100(0)	33(7)	31(9)	—
chlorpyrifos CRG ³	1.96	70(9)	100(0)	46(7)	67(9)	14(4)
phorate	1.00	47(9)	—	—	—	—
terbufos	0.60	39(9)	—	—	—	—
fensulfothion	0.55	89(6)	19(7)	—	—	—

¹ () $\pm$ SE of mean. MAT = months after treatment.

² Chlorpyrifos 140 g/kg, 1.0 mm diameter; CRG = controlled release granules.

³ Chlorpyrifos 140 g/kg, 0.6 mm diameter; CRG = controlled release granules.

TABLE 2: Trial 2: Residual effectiveness against grass grub larvae in bioassays of soil from renovated pasture treated with drilled applications of insecticides in November 1987 at Kiwitahi Land Co., Kinloch Taupo.

Treatment	Rate kg ai/ha	% mortality ¹				
		1st instar	3rd instar	2nd instar	3rd instar	2nd instar
		2 MAT	5 MAT	15 MAT	16 MAT	27 MAT
untreated		47(8)	15(5)	17(4)	24(5)	7(4)
chlorpyrifos CRG ²	0.49	100(0)	56(7)	53(6)	24(5)	18(6)
chlorpyrifos CRG ²	0.98	100(0)	83(5)	81(5)	63(6)	12(5)
chlorpyrifos CRG ²	1.96	100(0)	100(0)	97(2)	96(2)	30(7)
fensulfothion	1.1	100(0)	56(7)	12(4)	—	16(6)

¹ () ± SE of mean. MAT = months after treatment.² Chlorpyrifos 140 g/kg, 1.0 mm diameter; CRG = controlled release granules.**TABLE 3: Trial 3: Residual effectiveness against grass grub of insecticidal treatments drilled with pasture seed into soil in November 1987 at Swann's farm, Kinloch, Taupo.**

Treatment	Rate kg ai/ha	Field trial larval density					
		5 MAT ^d		17 MAT		28 MAT	
		log _e (x + 1) ^a	No./m ²	log _e (x + 1) ^b	No./m ²	log _e (x + 1) ^a	No./m ²
untreated		4.08	355	3.57	193	2.82	95
chlorpyrifos CRG ^c	0.49	3.15	137	2.90	107	3.44	160
chlorpyrifos CRG ^c	0.98	2.76	103	2.23	51	2.97	98
chlorpyrifos CRG ^c	1.96	2.52	70	2.35	64	2.81	85
fensulfothion	1.1	2.62	76	3.06	166	3.82	299
LSD (P = 0.05)		0.65		0.55		0.56	

^a x = number of larvae per 25 x 10 cm diameter soil cores per plot.^b x = number of larvae per 24 x 10 cm diameter soil cores per plot.^c Chlorpyrifos 140 g/kg, 1.0 mm diameter; CRG = controlled release granules.^d MAT = months after treatment.

largely reflected the bioassay results. In Trial 3 larval densities in the chlorpyrifos CRG treatments (0.98 and 1.96 kg/ha) were significantly lower 17 months after treatment than densities in untreated and fensulfothion treated plots (Table 3). Trial 2 gave similar results. After 2 years grass grub numbers had declined in the untreated controls and risen in the fensulfothion treatments but not in the chlorpyrifos CRG 1.96 kg/ha treatment (Table 3). In Trial 4 (Table 4) the results obtained against grass grub with chlorpyrifos 1.96 kg/ha were sustained using a chlorpyrifos CRG 100 g/kg formulation.

Prestidge and East (1986) noted that severe grass grub damage often occurs 2 to 4 years after (conventional) insecticide treatment, severe summer drought or cultivation and pasture renewal, all of which reduce grass grub numbers to low levels. It seems probable therefore that the chlorpyrifos CRG 1.96 kg/ha treatment will prevent grass grub from reaching damaging levels 2 to 4 years after treatment, which is longer than for conventional insecticide treatments such as fensulfothion granules. With growth of pasture reduced by 25-80% by larval densities of 200-300/m² (East *et al* 1981) following a dry summer, chlorpyrifos CRG, 140 g/kg may be a preferable option for insecticide treatment.

TABLE 4: Trial 4: Effect of insecticidal treatments drilled with pasture seed into soil in October 1988 at Gregory's farm, Reporoa, on grass grub numbers in the field and mortality in bioassay test.

Treatment	Rate kg ai/ha	Field trial larval density				Bioassay ^f 15 MAT
		7 MAT ^e		17 MAT		
		$\log_e(x+1)^a$	No./m ²	$\log_e(x+1)^b$	No./m ²	% Mortality
untreated		1.71	51	3.12	122	10(3)
chlorpyrifos CRG ^c	1.0	1.06	25	2.06	39	100(0)
chlorpyrifos CRG ^c	1.5	0.82	17	1.89	38	100(0)
chlorpyrifos CRG ^c	2.0	0.50	8	1.90	36	100(0)
chlorpyrifos CRG ^d	1.96	0.36	6	1.78	29	100(0)
fensulfothion	1.1	0.14	2	1.78	38	33(5)
LSD (P=0.05)		0.63		0.99		

^a x = number of larvae per 12 x 10 cm diameter soil cores per plot.

^b x = number of larvae per 25 x 10 cm diameter soil cores per plot.

^c Chlorpyrifos 100 g/kg, 1.0 mm diameter; CRG = controlled release granules.

^d Chlorpyrifos 140 g/kg, 1.0 mm diameter; CRG = controlled release granules.

^e MAT = months after treatment.

^f Bioassay of second instars () $\pm$ SE of Mean.

CONCLUSION

With conventional granules like fensulfothion only giving control of grass grub for a few months, resurgence of the pest occurs with major damage to pasture 2 to 4 years after treatment. With the advent of chlorpyrifos CRG the optimisation of insecticidal options can be realised because there is a sustained residual action against grass grub for up to 2 years.

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