CONTROL OF GRASS GRUB (*COL.*, *SCARABAEIDAE*) BY DRILLING INSECTICIDE GRANULES INTO PASTURE

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SUMMARY

Many insecticides are toxic to grass grub (*Costelytra zealandica*), in laboratory bioassays, but have given poor or erratic control when applied as granules on the surface of pasture. Four field trials were carried out to determine whether higher grass grub mortality could be achieved with some of these insecticides if they were drilled into pasture. Prothiophos, parathion, chlorpyrifos and terbufos gave as good control of grubs as those which are currently recommended for grass grub control; fensulfothion, isazophos, diazinon and lindane.

INTRODUCTION

Many insecticides have proved to be highly toxic to grass grub when applied topically or in pot trials and yet have not performed well when applied on the surface of infested pasture. Furthermore, many insecticides including those currently recommended for grass grub control (fensulfothion, diazinon, lindane, isazophos) have given highly variable results when broadcast as granules on the pasture surface because of low rainfall or reasons unknown (East *et al* 1981; Read 1969, 1970; Kelsey and Read 1967; Taylor 1968).

It is thought that drilling granules into pasture may give better control under conditions of low rainfall and also on some soil types where control of grass grubs from surface-applied insecticides have been poor, where a turf mat exists or for control of grass grubs with a two-year life cycle. In addition, the drilling of insecticides may allow reductions in application rate and stock withholding periods (East *et al* 1981) although some loss in effectiveness may result. There are, however, no known published comparisons of different insecticides as granules drilled into pasture for grass grub control.

This paper describes field trials to investigate whether insecticides which have been effective in laboratory tests but unsatisfactory when applied on the pasture surface, might give better control of grubs when drilled into the soil. The relative performance of currently recommended materials was also examined.

METHOD

Trial sites were in Southland on old ryegrass and white clover pastures at Wendonside on an Oreti stony silt loam soil, and at the Key on a Monowai silt loam. Insecticide granules were mixed with reverted superphosphate or sand and drilled into pasture at 1 or 2 kg ai/ha to a depth of 3 cm through the fertiliser box of Duncan Multiseeder Triple Disc drill or a Duncan Seedliner drill with sod seeding drill tips. Both drills had coulter spacings of 15 cm. Other details are given in Table 1.

Because mixed populations of one- and two-year life cycle grass grubs were present, insecticides were applied in summer in Trials I, II and III to control the damaging stage of both generations (Stewart 1975). In Trial IV however, the more conventional autumn treatment time was adhered to because most (95%) grubs were one-year. The insecticides tested are shown in Table 2.

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Treatments were randomly assigned to plots within four or five blocks. Grass grubs were sampled in Trials I to III by extracting them from seven samples 16 x 16 x 15 cm deep dug by spade in each plot, and in Trial IV from 20 cores (10 cm in diameter x 15 cm deep) per plot. Grubs with a one-year life cycle were distinguished from those with a two-year life cycle by differences in their stage of development (Stewart 1975).

Visual estimates of pasture damage were made independently by two assessors.

Analyses of variance were performed on natural logarithms of density of grubs of each life cycle per plot.

RESULTS AND DISCUSSION

In each trial the effects of treatments on grubs with a two-year life cycle were not significantly different from those with a one-year life cycle ($P > 0.05$). For simplicity therefore data for all larvae have been pooled (Table 2).

In Table 2 insecticides have been ranked according to their mean level of effectiveness in Trials I to III but not in Trial IV where control by all materials was low for reasons which will be discussed below. Other insecticides which were used in the trials but gave no significant control of grass grub ($P > 0.05$) were chlormephos and dialiphos (Torak) in Trials I and II; phorate (Thimet), triazophos (Hostathion), Fenitrothion (Fenitrothion) and carbofuran (Furadan) in Trial III; carbofuran and disulfoton (Disyston) in Trial IV.

TABLE 1: Details of field trials.

Trial	Site	Drill	Plot size(m)	No. of replicates	Carrier for insecticide	Rate (kg ai/ha)	Treatment date	Assessed
I	Wendonside	Duncan Multiseeder	2.5 x 20	4	Reverted superphosphate	1	11/01/75	12/5/75
II	Wendonside	Duncan Multiseeder	2.5 x 20	4	Reverted superphosphate	2	24/01/75	13/5/75
III	The Key	Duncan Seedliner	1 x 20	5	Sand	2	17/12/75	15/5/76
IV	Wendonside	Duncan Multiseeder	2.5 x 8	5	Sand	2	18/04/78	22/6/79

Although in all trials the majority of treatments gave significant control of grubs, there were few significant differences between insecticides: parathion, fensulfothion and prothiophos acted better than the remainder in Trial I; fensulfothion better than lindane and fonofos in Trial II; and ethoprophos better than parathion, chlorpyrifos, terbufos and lindane in Trial IV ($P < 0.05$). It is of interest that, in one or more trials, prothiophos, parathion, chlorpyrifos and terbufos, materials not currently recommended or registered for grass grub control, individually gave similar control of grass grubs to the currently recommended materials diazinon, fensulfothion, lindane and isazophos (East *et al* 1981).

The reported inconsistency in effectiveness of surface-applied parathion and chlorpyrifos, which have sometimes performed well against grubs (McLean 1969, Read 1969), and sometimes poorly (Rastrick and Upritchard 1967, Read 1970) may be related to differences in post-treatment rainfall which is needed to wash the insecticides into the soil (McLean 1969). The present results with these chemicals suggest that they may be more reliable and less dependent on rainfall when applied below the surface.

Surface-applied lindane acts mainly on adult grass grubs when they emerge in spring so that reductions in the density of larvae are usually not seen until the second generation (Henzell *et al* 1981). However, in all trials except III applications were made after the beetle flight period had finished so the activity of lindane must therefore have been directly on larvae. This was probably largely true for Trial III also, because granules drilled below the soil surface give poor control of adults (Lauren *et al* 1982).

TABLE 2: Control of grass grubs by insecticide granules drilled into pasture. Data are $\log_e$ grubs/m² with percent control in brackets.

Treatment	Granule concn. (%)	T R I A L			
		I	II	III	IV
fensulfothion (Dasanit)	10	4.93 (66)	4.36 (84)	4.32 (53)	5.90 (32)
parathion (Niran)	10	4.80 (70)	4.44 (83)	4.49 (44)	5.94 (20)
prothiophos (Tokuthion)	10	4.97 (64)	5.03 (69)	4.31 (54)	-
chlorpyrifos (Lorsban)	10	5.00 (63)	4.80 (75)	4.42 (48)	5.95 (28)
isazophos (Miral)	10	5.53 (37)	5.05 (68)	3.92 (69)	5.68 (45)
diazinon (Dyzol)	20	5.59 (34)	5.05 (68)	4.11 (62)	5.73 (42)
ethoprophos (Mocap)	10	5.32 (49)	5.03 (69)	4.48 (45)	5.58 (50)
terbufos (Counter)	20	5.38 (46)	4.48 (82)	4.67 (33)	5.96 (28)
lindane (Lindane)	20	5.14 (58)	5.15 (65)	4.67 (34)	5.95 (29)
isophenphos (Oftanol)	10	5.70 (26)	5.05 (68)	-	-
fonofos	5	5.42 (44)	5.96 (21)	-	-
untreated	-	5.99 (-)	6.20 (-)	5.08 (-)	6.28 (-)
No./m ²		399	492	160	534
SED		0.26	0.35	0.44	0.17

Inspection of Trials I and II about 2 weeks after insecticide application showed that most grubs close to drill lines were dead whereas those between the drills were apparently unharmed. The lateral penetration of insecticides through pasture soil is limited to about 12 mm (Trought and Wood 1970) so that grass grub mobility must be an important factor leading to high mortality when insecticides are placed in bands 15 cm apart. Lateral movement of grass grub increases when their food supply is reduced (W.M. Kain pers comm); consequently, in the present trials, grub mortality may have been closely linked with pasture damage. Poor grub control was obtained in Trial IV where pasture growth in untreated plots was much more vigorous than in other trials in spite of the high density of grubs present; and the best overall control ($P < 0.05$) by all insecticides applied at 2 kg ai/ha was obtained in Trial II where pasture damage was the most severe. Correlation coefficients between grub density and damage rating was highly significant in Trials I and II ($r = 0.92***$ in each case). Damage was not visible in Trial III where grass grub density was low, or in the vigorous Trial IV pasture. If control of grass grub by drilled insecticides is less effective when pasture growth is vigorous, surface applications may be required, or if granules must be drilled in anticipation of damage, an insecticide with good residual activity such as lindane may be required.

Overall control by insecticides in Trial I was lower than in Trial II ($P < 0.05$) probably due to the lower rate of application (1 kg ai/ha) because most other factors (year of application, soil type and locality) were the same in each trial (Table 1).

Comparison of grass grub control in Trials I and II, in which the carrier used for insecticide granules was reverted superphosphate, with that in Trials III and IV in which sand was used, do not indicate inactivation of insecticide by the fertiliser; and so these results provide no reason why farmers should discontinue their practice of applying granules mixed with reverted superphosphate through seed drills.

CONCLUSIONS

The choice of insecticides for drilling into pasture would appear to be wider than for surface applications. No material appeared to be consistently more effective than those already recommended for grass grub control, but a wider choice is of advantage since prices of individual insecticides can fluctuate considerably. Also, when insecticides are drilled with seed, it may be possible to control not only grass grub but other pests for which different insecticides are recommended.

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