A COMPARISON OF LINDANE BROADCAST AND DRILLED IN SPRING FOR GRASS GRUB BEETLE CONTROL

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SUMMARY

Broadcast applications of lindane (1 kg/ha) applied in September prior to beetle emergence and mating, gave 80-88% control of the subsequent grass grub (*Costelytra zealandica*) populations. These results were significantly better than those obtained (41-70% control) using drilled applications at 1 kg/ha. Lindane residues from broadcast treatments remained in the upper layer of the soil while residue from drilled treatments remained localised in the drill rows, even after 7 months. Residue levels from all treatments dropped substantially over the summer. It is suggested that the permit period for broadcast applications of lindane be extended to October.

INTRODUCTION

Henzell *et al* (1981) reported that lindane had greater contact activity against grass grub beetles than against larvae. They showed that lindane broadcast in spring about one month before the start of the grass grub beetle primary emergence and mating period gave significantly better control of the grass grub population than applications made in the preceding April. It was suggested that the only reason that the common autumn/winter applications are able to have an effect on grass grub populations is that the long residual life of lindane allows it to remain in the soil at toxic levels until the beetle emergence time. A further trial confirmed that despite the presence on the soil of lindane residues potentially lethal to larvae from autumn applications, no effect was obtained until the spring (Authors' unpublished data).

Current regulations for lindane preclude its use as a broadcast treatment close to the beetle primary emergence and mating period. Drilled applications are allowable at any time of the year, but no published information is available on the relative effectiveness of broadcast and of sub-surface applications against beetles. It is likely that the localisation of a highly water insoluble insecticide such as lindane in drill rows could substantially reduce the chance of contact with the emerging adult grass grub.

In this work we report on a comparison between drilled and broadcast treatments of lindane applied in early spring, approximately 6 weeks before beetle primary emergence time. Both the effects on the resultant grass grub population and chemical residue analysis results are given.

METHODS

Three trial sites were used. Site 1 at Whakamaru was on an Oruanui loamy sand, Site 2 was at Ngongotaha on Oturoa sand, and Site 3 was at Owata on Rotomahana shallow sandy loam. At each site, at least 18 plots (10 x 2.45 m) were set out in a row with no buffer strips between adjacent plots. On September 7-8, 1981, grass grub populations at the three sites were assessed by taking 20 soil cores (10 cm diam.) from the mid-area (8 x 0.5 m) of each plot. Plots used for the trial had populations in the ranges 51-146, 25-89 and 44-268/m² for sites 1, 2 and 3 respectively. The two treatments and a control were randomly allocated to plots in groups of three along the row. Some minor readjustment was then made to ensure that each treatment covered a representative population range. Each treatment had six replicates.

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Treatments were applied on September 15-16, 1981. Foliage was dry and less than 5 cm long at all sites. Broadcast treatments were made using a 'Horstine' granule applicator set to apply lindane (20% granules) at 1 kg/ha. Drilled treatments were applied using a 'Duncan' triple-disc drill with the active formulation (20% granules) bulked up three times with blank granules. Lindane was applied at 1 kg/ha in rows 15 cm apart. The drill depth was estimated at 2 cm for sites 2 and 3 and at 1 cm for site 1 where the granules were left on a line on the surface on an estimated 10% of each plot.

Post treatment grass grub populations were assessed in early April 1982 by taking 24 soil cores (10 cm diam.) from the mid-area of each plot.

Results from each trial site were assessed by analysis of variance of the log transformed data.

Residue analyses

Samples were collected for lindane residue analysis at four times from each site:

1. two weeks after application,
2. in mid-November 1981, at the end of the beetle primary mating period,
3. in mid-January 1982, and
4. in late April 1982.

Broadcast treatments were sampled by taking 10 soil cores (2.5 cm diam.) from within each of the six replicate plots. The cores were at least 50 mm deep, and were sectioned into 0-10, 10-20 and 20-40 mm layers, and the rest discarded. Each layer was bulked, combining equivalent layers from all replicates. Samples were stored at -5°C until analysed.

To facilitate sampling of the drilled plots, the drill rows were marked in the end 1 m sections of each replicate. Soil cores (30 x 2.5 cm diam.) were taken from: a) on rows; b) 3.75 cm from rows, and c) 7.5 cm from rows (mid-point) and sectioned and stored as for broadcast samples.

Lindane residues were extracted by standard techniques and analysed by gas chromatography (Lauren *et al* 1980). The 0-10 mm layers were analysed with pasture foliage removed but including the turf mat.

RESULTS

Table 1 summarises the effects of the two different treatments of lindane at the three trial sites. All treatments were significantly different from untreated ($P < 0.01$), and broadcast treatments gave significantly greater control than drilled treatments ($P < 0.01$). No significant site effect for treatments could be found.

Results from lindane residue analyses for the November, January and April samplings are shown in Table 2. In a few instances, the soil level with highest concentration has changed from one date to the next, but this is due more to variation in sampling and placement by the drill rather than to any downward movement of the

TABLE 1: Reductions in grass grub numbers at three sites by spring broadcast and drilled treatments of lindane (1 kg/ha).

Site	Initial Pop ⁿ¹ (larvae/m ²)	% Control ²		Untreated Pop ⁿ³ (larvae/m ²)
		Broadcast	Drilled	
1	106	88	70	61
2	56	88	52	70
3	138	80	41	188
Treatment mean		85	54	

¹ Average population over all plots.

² % reduction in larval population of treated plots compared to untreated plots.

³ Average population in untreated plots at post-treatment assessment.

insecticide. The residue data for September (2 weeks after application) are not shown, since, in general, the residue levels in November were little changed from those found in September. The only exceptions were from Site 1, in the 0-10 mm layers from between the drill rows. In both cases unexpectedly high residue levels for these positions were obtained, from 4-16 times the September values for the 3.75 and 7 cm positions respectively. This will be commented on later. In most cases, the residue levels in January are lower than in November. This trend continued to the April sampling when residue levels had dropped substantially.

TABLE 2: Lindane residues¹ found in different soil layers at three sampling dates from broadcast and drilled treatments at each of three trial sites.

Depth (mm)	Site 1			Site 2			Site 3		
	Nov	Jan	Apr	Nov	Jan	Apr	Nov	Jan	Apr
Broadcast									
0 - 10	21.7	10.6	1.5	14.5	5.8	2.4	20.0	15.8	1.5
10 - 20	0.4	1.1	0.6	0.2	0.2	1.6	2.1	1.1	1.5
20 - 40	0.2	0.1	0.0 ²	0.2	0.1	0.3	1.2	0.1	0.2
Drill row									
0 - 10	51.5	8.0	5.8	0.5	- ³	0.2	10.3	0.9	0.8
10 - 20	15.7	0.8	4.8	40.4	-	0.7	10.8	4.4	2.8
20 - 40	0.4	0.1	0.9	20.3	-	0.7	5.3	15.0	4.9
3.75 cm off drill row									
0 - 10	9.9	4.2	1.1	0.0	-	0.1	0.4	-	0.1
10 - 20	0.2	0.5	0.4	0.0	-	0.0	0.0	-	0.4
20 - 40	0.1	0.0	0.0	0.0	-	0.2	0.0	-	0.4
7 cm off drill row									
0 - 10	16.0	1.6	0.4	0.0	-	0.1	0.1	-	0.0
10 - 20	0.2	0.1	0.1	0.0	-	0.0	0.0	-	0.0
20 - 40	0.1	0.0	0.0	0.0	-	0.0	0.0	-	0.0

¹ Expressed at $\mu\text{g/g}$ with respect to soil dry weight.

² $0.0 = < 0.05 \mu\text{g/g}$ detected.

³ Not determined.

DISCUSSION

The present set of trials has again shown good control of grass grub from broadcast lindane (1 kg/ha) applied within 1-2 months of beetle primary emergence and mating. (The major grass grub mating flights at the three sites have been found to begin between October 25 and November 8 in previous years). The drilled treatments (1 kg/ha) applied at the same times were found to be less effective. This suggests that the beetles do not make adequate contact with the drilled insecticide. The numerically better control from the drilled treatment at Site 1 (albeit not significant) may reflect the fact that on this site some of the drilled chemical was surface applied, and may have achieved greater lateral spread than at sites 2 and 3. This is supported by the residue data from Site 1 which shows insecticide in the 0-10 mm layer between the drill rows. As mentioned earlier, the November values were unexpectedly high, but the fact that this layer showed lindane residues at each of the four sampling dates indicates that some lateral spread definitely had occurred. This can be contrasted with the results from sites 2 and 3 which show almost no lindane outside the drill rows.

Table 2 shows a marked loss of lindane from the soil between November and April. This trend occurs to the same extent for both broadcast and drilled treatments, with losses in the range of 80-90%. In other trials, broadcast treatments have been found to retain high insecticide levels for several months over winter and spring, but to lose them over the summer (authors' unpublished data). It appears that lindane, a volatile chemical, dissipates from the soil over the hot summer months. This would obviously preclude the possibility of lindane affecting larvae the year after application.

The drilled treatments, by virtue of their concentration of the insecticide within the rows, generally retained higher absolute residue levels in April than the broadcast treatments. It is likely that these reduced levels would remain for the remainder of the winter. The possibility of a second year effect on the beetles therefore exists. However, given the low control obtained with the high residue levels present in the drill rows directly after application, the chance of a significant second year effect seems small. In addition, as site 2 shows, drilling in cannot be relied upon to enhance the residual levels of lindane.

This set of trials has shown that drilled applications of lindane applied prior to grass grub beetle emergence give inferior control to broadcast applications. The use of drills to apply insecticides in autumn has been increasing since it allows the insecticide rate to be reduced compared to broadcast, with consequent cost saving, although the level of control is also reduced (Carpenter *et al* 1981; East *et al* 1981). This cost saving measure is suspect when applied to spring applications of lindane, since the present results show broadcast treatments at 1 kg/ha, half the recommended rate, gave substantially greater control than drilled treatments. Henzell *et al* (1981) and Kain and Atkinson (1968) have shown that still greater control is obtainable with broadcast application at 2 kg/ha applied prior to adult emergence. Drilled treatments are thought to be less variable than broadcast, but in fact they localise the lindane in rows and make it less likely to contact the beetles. Drilled treatments may reduce the potential problem of livestock accumulating lindane residues, however, the problem from broadcast applications may be exaggerated. Collett and Harrison (1968) showed that lindane was rapidly eliminated from stock held on untreated pasture.

Both the present results and those of Henzell *et al* (1981) show that a relaxation of the present permit regulations to allow broadcast applications of lindane up to October would be in order. Applications could then be made closer to the time when lindane acts on grass grub, namely at the adult emergence period. Farm management procedures and climate within a region would dictate when the most suitable application time would be. Provided the present withholding period is followed and that stock are held on untreated pasture for at least one month prior to slaughter, lindane residues in stock carcasses should not increase above present levels (Collett and Harrison 1968).

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