BLACK BEETLE CONTROL IN PASTURE FROM LINDANE TREATMENTS AGAINST THE ADULT

R.N. WATSON and R.S. MARSDEN

Ruakura Soil and Plant Research Station, MAF, Private Bag, Hamilton

SUMMARY

Lindane (1 kg ai/ha) as 20% pellets broadcast onto pasture in April gave a poor reduction of adult black beetle (*Heteronychus arator*) numbers after one month. There was a progressive reduction in adult numbers, relative to untreated populations, through the spring and summer, resulting in an 86% reduction in summer larval populations. Pot trials showed that the poor initial activity was the result of lindane pellet formulations not releasing the insecticide readily.

INTRODUCTION

Pasture damage by black beetle occurs over the summer months as a result of larval root pruning. The adult can also cause losses of susceptible grasses by feeding at the base of tillers in autumn and spring. Insecticidal control of black beetle in pasture has been largely directed at the larval stage, but effective control should also result from a reduction in adult numbers (Watson *et al* 1980).

Lindane has been used overseas to control adults of black beetle and related dynastid species in crops (Graham *et al* 1959; Drinkwater 1982). In New Zealand Todd (1967) showed that lindane treated superphosphate watered onto small pasture plots gave excellent control of black beetle adults, but larvae were not so successfully controlled. Lauren and Henzell (1984) found autumn application of lindane pellets gave effective grass grub (*Costelytra zealandica*) control, but largely as a result of residual toxicity affecting the adult stage in spring. This paper discusses an evaluation of autumn broadcast lindane for control of black beetle in pasture.

MATERIALS AND METHODS

Field trial

Lindane (Shell 20% pellets) was applied to pasture at 1 kg ai/ha by ISIS applicator on 16 April 1981 on Ohinepanea sandy loam (Kaharoa ash) at Otamarakau, coastal Bay of Plenty. Four replications of paired, treated and untreated plots each measuring 50 x 50 m were established on flat areas within a large paddock dissected by gullies. Prior to treatment black beetle populations were assessed from 100 soil samples, 100 mm in diameter, taken from a 15 x 15 m area in the middle of each plot. After treatment, 0.5 m^2 plastic flyscreen covers were pinned onto pasture (5 on untreated, 10 on treated) to enable counts to be made of beetles which died on the surface. Beetle cadavers were counted 32 days after treatment from covered and adjacent uncovered areas of equal size after clipping pasture to ground level.

On 15 July 10 pitfall traps (King *et al* 1980) were established on the 15 x 15 m area on each plot and protected with upturned wire milk crates. Contents of the pitfalls were assessed fortnightly through the trial period. On 20 January 1982, and on 17 March 1983, 100 soil samples were taken adjacent to the 15 x 15 m areas to determine black beetle larval numbers.

Pot trials

A. In conjunction with the field trial, the adulticide activity of the lindane applied to pasture was compared with other insecticide treatments (Table 1). Pots 150 x 150 mm surface dimension containing soil were topped with a 70-80 mm depth of ryegrass/white clover turf. Five beetles were added to each pot on 10 April 1981 and allowed to settle beneath the turf. Five replicates of treatments in Table 1 were applied later in the day.

TABLE 1: Black beetle mortality one month after application of insecticide in pots.

	Treatment date	10.4.81	10.4.81	14.5.81	24.6.81
	Assessment date	27.4.81	12.5.81	19.6.81	23.7.81
Treatment	Rate (kg ai/ha)		% mortality		
lindane 20P	2.0	20	—	—	
lindane 20P	1.0	7	30	0	—
lindane 20P	0.5	0	10	—	—
isazophos 10G	2.0	100	70	56	56
isazophos bait	0.5	33	30	—	—
fensulfothion 10G	2.0	20	30	—	—
untreated	—	0	0	0	0

Pots were covered with flyscreen mesh and maintained outdoors, sunk into soil to the level of the turf. Three replicates were destructively sampled after 2 weeks and the remaining two after 4 weeks. Some treatments were repeated on 14 May 1981 and on 24 June 1981 to determine if insecticides applied to adults in the overwintering, inactive state affected control. These pots were sampled after one month.

B. Because of disappointing results with lindane in the above trials, two further pot trials were conducted in 1982. One aimed to test lindane pellets by repeating the experimental methods of Todd (1967). In the other, commercial pellet formulations were compared with lindane EC.

For the first trial pots were prepared as in A above. In addition fibrolite bordered plots 628 x 628 mm were established in paspalum dominant turf. Twenty beetles were placed into both the pots and field plots on 8 April 1982 and treatments (Table 2) were applied 24 h later. Watering after lindane application was at rates used by Todd (1967), equivalent to 5.8 mm rainfall. Two treatments of the pot trial were kept at 20 °C in a constant temperature room to examine if cool ambient temperatures in April affected control. Beetle mortality was assessed by destructive harvesting after one month.

TABLE 2: Black beetle mortality one month after treatment with 1 kg ai/ha lindane pellets.

	% mortality		
Treatment	Pots outdoors	Pots 20 °C c.t.	Small plots outdoors
lindane watered, open to rain	8	—	20
lindane watered, protected	—	0	—
lindane unwatered, open to rain	4	—	11
lindane unwatered, protected	4	4	6
untreated	0	—	—

In the second pot trial four commercial pellet formulations of lindane (Nexa 12%, Shell 20, Tartan 20 and Bayer 20) and Lindane 20EC were shaken into Horotiu sandy loam soil (31% moisture) at 4 ppm. Care was taken to avoid crushing the pellets. Eight beetles were placed into each of four replicates on 19 May 1982 and pots were maintained at 20 °C. Beetles were dug up and replaced on the soil surface. Those unable to rebury themselves were classed as dead or affected. Assessments were conducted at intervals up to 29 days after treatment.

RESULTS

Field trial

The initial black beetle populations were 16.2 ± 3.5 SE/m^2 and 21.3 ± 3.6/m^2 on

treated and untreated replicates respectively, of which 91% were adult and the remainder stage III larvae. Dead beetles recovered from beneath the covers 34 days after insecticide application were equivalent to $4.5 \pm 2.1/m^2$ and $1.2 \pm 0.8/m^2$ on treated and untreated plots, representing a reduction of 27.6 and 5.5% of the original populations (Abbotts mortality = 23% from lindane). Numbers of dead beetles found on the treated uncovered areas were only slightly lower than on the covered areas. Observation of black beetle remains in hedgehog scats indicated removal of some of the unprotected beetles. Chemical analysis of the lindane pellets at the time of application confirmed that the active ingredient had been up to specification.

Numbers of beetles trapped in pitfall traps are shown in Fig. 1. Beetles caught up to 11 September represented a 35% reduction by the treatment. From 11 September to 23 October there was a 59% reduction and between 23 October and 20 January an overall reduction of 81%. The higher adult reduction in the later period, coinciding with egg laying, was reflected in an 86% reduction in larval numbers (from 33 ± 9 to $4.8 \pm 2.7/m^2$) in January. Beetles trapped in pitfalls after February represented adults of the succeeding generation. The numbers were also reduced by an average of 81% on lindane treated areas.

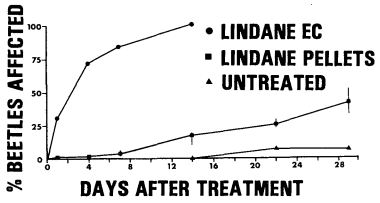

Fig. 1: Black beetle numbers in pitfall traps during the season following autumn application of lindane pellets on pasture.

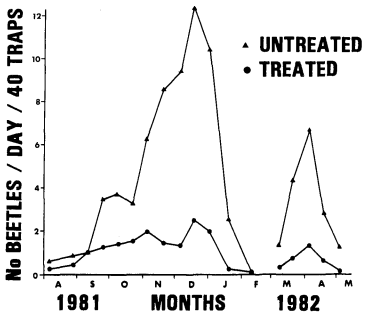

Fig. 2: Black beetle mortality from lindane EC and pellet treatments (mean of four brands with range) during the month after soil treatment.

During spring 1982, total adults in pitfall traps were 380 on untreated and 74 on treated, again a reduction of 81% and indicating no additional activity by the lindane on the second generation adults. On 17 March 1983 larval numbers were only 37% below the untreated population of $21/m^2$, indicating a differential natality or larval mortality in favour of the lindane in the second year after treatment. Potential predator densities of *Thyreocephalus orthodoxus*: Staphylinidae were only slightly reduced by lindane, but wireworms, mainly *Conoderus exsul*: Elateridae were almost entirely eliminated, compared to a density of $6/m^2$ on untreated plots.

Pot trials

A. Lindane at 1 kg ai/ha gave a 7% and 30% reduction in beetles after 17 and 32 days respectively in the April treatment, possibly indicating a progressive, but low overall effect (Table 1). The mortality after one month was in agreement with the field trial. Only isazophos at 2 kg ai/ha gave an effective reduction of adults. The effectiveness of treatments after April was reduced, coinciding with cooler soil temperatures and overwintering inactivity of beetles.

B. Black beetle mortality one month after application of lindane pellets was low on all treatments of the first pot and small plot experiments and did not exceed 20% (Table 2). Pellet formulations had a delayed, but progressive effect against black beetle, compared with the EC treatment (Fig. 2). In the second trial there was no significant difference between pellet brands which reached 40% mortality after one month. Lindane EC mortality was 84% after 7 days and 100% within 2 weeks of treatment.

Similar differences between EC and pellet formulations of lindane were reported by du Toit *et al* (1979) in tests against grass grub.

DISCUSSION

There was a poor reduction in numbers of adult black beetle immediately after field application of lindane pellets in autumn, and this was supported by pot trial results. The difference in adult numbers between treated and untreated plots gradually increased through the adult period, and was reflected in an effective reduction of larval populations in summer. The poor initial effect from lindane pellets appeared to relate to slow release of the active ingredient, and this was not substantially influenced by watering or rainfall after application. Lauren *et al* (1984) suggested that, given the immobility of lindane in soil, the 20% pellet formulation results in insufficient coverage of the soil surface. They suggested both rainfall and stock movement are required to give a good distribution of lindane away from the immediate area of the pellets.

While broadcast application of lindane pellets in autumn may provide control of black beetle larvae in pasture by the following summer, they should not be applied where the immediate reduction of adult numbers is the main objective, such as in renovated pasture, crops of greenfeed grass species, or cereals. Alternative formulations of lindane may provide very good control of black beetle adults in these situations.

ACKNOWLEDGEMENTS

We would like to thank R.J. Townsend and R.S. McGhie for technical assistance; Dr D.R. Lauren for analysing lindane pellets and D. Blennerhassett, Otamarakau for cooperation during the field trial.

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