CONTROL OF GRASS GRUB BY FOUR TYPES OF ROLLER

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SUMMARY

Four types of heavy roller were tested for the control of grass grub (*Costelytra zealandica*) in pasture. A conventional 10 tonne agricultural roller gave no significant grass grub mortality or pasture yield increase. The other rollers which were specially constructed for grass grub control, gave from 35% to 53% reduction in grass grub numbers and from 18% to 25% increase in spring pasture yield in the following growing season. These effects were not as great as those from fensulfothion insecticide broadcast on the pasture surface at 2 kg ai/ha (78% and 67% respectively). The reduction in grub density from two rollers and also from fensulfothion persisted into the following season.

INTRODUCTION

The rolling of pasture infested with damaging populations of grass grub with a 22 tonne agricultural roller (Stewart 1979) and a tandem roller of 8 tonnes (Stewart and van Toor 1983) gave up to 61% mortality of grass grubs and 44% improvement in spring pasture production. This paper compares the tandem roller with three other types of roller, and fensulfothion insecticide for grass grub control and subsequent pasture yield increase.

MATERIALS AND METHODS

The trial was laid down on 4 May 1982 on pasture visibly damaged by grass grub at Wendonside, northern Southland on a YGE Oreti stony silt loam. The pasture was composed of white clover (*Trifolium repens*) and grasses, predominantly ryegrass (*Lolium perenne*) and sweet vernal (*Anthoxanthum odoratum*).

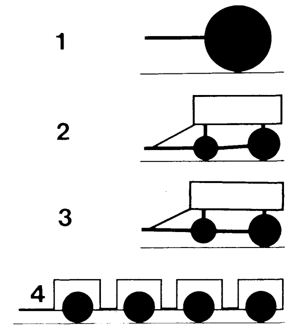
Treatments

Treatments were an untreated control, fensulfothion insecticide granules (Dasanit 5G) applied at 2 kg ai/ha by hand shaker, and one pass with one of four different rollers (Fig. 1). Roller 1 was a conventional water-ballasted agricultural roller commonly used to consolidate soil and depress stones. Roller 2 (Stewart and van Toor 1983) had circular grooves 50 mm deep x 100 mm wide x 100 mm apart in the front roller, and a smooth-surfaced rear roller both under a loaded platform. Roller 3 was the same rolling apparatus as Roller 2 with the same load but operated with the front roller lifted off the pasture surface by the two-point linkage of the tractor. Roller 4 had four bogeys each composed of two truck tyres at 413 kPa pressure, and weighted by concrete blocks of about 2 tonnes. The bogeys were pulled in staggered formation to give 1.4 m width of rolled pasture. All rollers were towed at 4 km/hr by a 63 kw tractor with rear wheel drive. Ground pressure from each roller (Fig. 1) was calculated from the formula: weight of roller (kg) x gravity (9.8 Newtons)/measured contact area (m^2) of the roller with the pasture surface.

Roller drawbar pull was measured with a hydraulic dynamometer linking the tractor with the rollers except for Roller 3 where the tractor bore part of the weight of the roller. The load on Roller 2 was the maximum achievable before wheel slip of the tractor occurred and gave the greatest drawbar pull. Roller 4 was unstable on uneven pasture and required a large turning circle.

Soil measurements

Soil moisture at the time of treatment was measured by taking cores at 0-50 mm, 50-100 mm, 100-150 mm depths; these were 41, 33 and 31% of soil dry weight



Roller	Total weight (t)	Width (m)	Diameter (m)	Drawbar pull (kg)	Calculated ground pressure (kPa)
1	10	3	1.5	568	109
2	7.3	2.2	Front 0.4 Rear 0.6	1589	253
3	6.3	2.2	0.6	—	259
4	14	1.4	1.1	908	440

Fig. 1: Description of rollers.

respectively. Field capacity at these depths was estimated by the method of Rickard and Cossens (1966) and was 48, 36 and 35% of soil dry weight respectively.

The day after treatments were applied, soil bulk density was estimated from the dry weights of 16, 50 mm diameter cores taken at three depths, as above, after surface thatch had been removed.

Grass grub sampling

Grass grub were sampled 10 days before treatments were applied, and on subsequent dates shown in Table 1. Thirty cores 100 mm in diameter and 200 mm deep were taken per plot on the first two occasions and the cores divided into 3 depths, 0-50 mm, 50-100 mm and 100-200 mm. In the following year, 20 cores per plot were taken and the cores were not divided. Healthy and diseased grubs from cores were counted.

Pasture measurements

Pasture dry matter production was assessed by mowing 0.46 x 20 m strips to 20 mm high when pasture height reached 100 mm. Six cuts were taken in 1982-83.

Sward composition was assessed by point analysis (100 cover hits per plot) in June and October 1982 and in March 1983 recording ryegrass, other grasses, white clover,

TABLE 1: Effect of rolling and insecticide on pasture yield and grass grub on 3 dates after treatment on 4 May 1982. Data in brackets are percent mortality of grass grub or percent increase in yield.

Treatment	Grass grub/m^2					Pasture yield (kg DM/ha)	
	May 1982			Sept 1982	Sept 1983	October 1982	Total 1982-83
	Second instars	Immature third instars	Mature third instars	Total larvae	Total larvae		
Untreated control	53	320	121	130	230	941	6099
Roller 1	48(9)	281(12)	133(0)	117(4)	207(10)	846(0)	6038(0)
Roller 2	39(26)	129(60)	84(30)	63(52)	179(22)	1180(25)	6474(6)
Roller 3	53(0)	162(49)	85(30)	85(35)	147(36)	1118(19)	6502(7)
Roller 4	38(28)	112(65)	73(40)	61(53)	130(43)	1115(18)	6359(4)
fensulfothion	—	—	—	29(78)	72(69)	1575(67)	7175(18)
Least significant ratio (5%)	1.7	1.4	1.5	1.2	1.5	1.2	1.05

bare ground, dead matter and weeds. Composition was also assessed by full species dissection of herbage cut from 6,300 x 50 mm strips in each plot in December 1982, February and May 1983.

Analysis

Analysis of variance of grass grub density was performed after transformation of data to natural logarithms. The LSR (Table 1) is the back-transformed least significant difference between the means of $\log_e$ transformed data. Back-transformed data have been used in tables. Pasture data were not transformed before analysis. Unless otherwise stated, differences between treatments will be discussed at the 5% level of significance.

Trial management

After soil testing, potassic superphosphate at 250 kg/ha was applied to the trial area in October 1982. After the first pasture cut, the loss of nitrogen from the sward was compensated by the application of inorganic nitrogen at 3% by weight of dry matter removed. The trial was grazed at 400 sheep/ha for 2 days after the second and third pasture cuts.

RESULTS

Soil

Although all rolling treatments significantly increased soil bulk density the increases, from 893 kg/m^2 to between 944 and 977 kg/m^2, occurred above 50 mm only, and there were no significant differences between rollers.

Mortality of Grass Grub

Ten days before treatments were applied, the grass grub population was $486/m^2$. The vertical distribution of grass grub between the 0-50 mm, 50-100 mm, and 100-150 mm levels was 56%, 32% and 12% respectively. Similar proportions of each developmental stage were present at each depth: 14% overwintering second instars, 61% immature (feeding) third instars and 25% mature (non-feeding) third instars.

Rollers 2 and 4 caused 60% and 65% mortality of immature third instars when effects were measured 10 days after rolling (Table 1). Control of this stage achieved with Roller 3 (49%) was significantly less than for Roller 4. Only Roller 4 caused significant mortality of mature third instars (40%). None of the rollers gave significant mortality of second instars.

Control measured in September 1982 was proportionately similar to that recorded in May although grass grub populations had declined in all treatments probably due to a bacterial disease, *Serratia* sp. affecting 17% of larvae in September. No relationship was found between treatments and disease. By September the second instars present in May had mostly developed to immature third instars, and the other larvae had matured or pupated. By this time, fensulfothion insecticide had caused greater mortality of larvae than any of the rolling treatments viz. 86% of mature larvae, and 78% of total larvae (Table 1). Pupae were not significantly affected by treatments.

Significant reductions in grass grub density were seen in fensulfothion and Rollers 3 and 4 treatments when grass grub was sampled in the following September (1983). Most (97%) grubs were present as third instars.

There were no significant relationships between the degree of compaction of soil and grass grub mortality, nor between mortality and the depth of larvae.

Pasture responses

Pasture growth was vigorous at the trial site and little visual damage from grass grub was observed after winter 1982. Nevertheless in comparison with the untreated plots over the 1982-83 season, significant increases in pasture mass were recorded for Roller 2 (6%), Roller 3 (7%) and fensulfothion (18%) (Table 1). The increases were measured mainly at the first cut on 19 October.

All treatments except Roller 1 gave minor changes in pasture composition, all considered to be beneficial. The most significant of these, which may have contributed to the increases in spring pasture yield, was an increase in the ryegrass component from 8% to between 14 and 19% of dry matter in October 1982.

DISCUSSION

Relative to a previous trial (Stewart and van Toor 1983), Roller 2 caused similar mortality of actively-feeding grass grub (60%, *cf* 64%), but gave a lower response in spring pasture yield (25% at the first cut *cf* 44% for the average of the first two cuts) probably because pasture in the present trial was more vigorous. Fensulfothion insecticide performed better than any of the rollers, although in a further trial (van Toor and Stewart 1986) it gave poor control of grass grub (46%) compared with 65% for rolling at the optimum time of year (March).

If the cost of the roller is excluded, rolling at a contract rate of $8 is more cost-effective for grass grub control than the use of fensulfothion at $194/ha for material + $6/ha for application. Unfortunately, Roller 1, which is already available on some farms, did not prevent pasture damage. The construction and use of Rollers 2 and 3 could be justified if extensive areas of pasture are to be treated (Stewart and van Toor 1983). Roller 4, if modified to eliminate its design faults, would be especially suitable for stony pasture where rigid rollers have been ineffective (K. Stewart unpublished).

Roller 3, a type which could be cheaply adapted from small diameter farm rollers for approximately $1000, would appear from this trial to be more cost-effective than the other rollers costing $8000-$120000. Further investigations on Roller types 2, 3 and 4 have been carried out (Stewart and van Toor in prep.).

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