THE IMPORTANCE OF APPLICATION TIME WHEN SYNTHETIC PYRETHROIDS ARE USED TO CONTROL ADULT GRASS GRUB

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Summary

Cypermethrin at 0.05 and 0.1 kg/ha and permethrin at 0.1 and 0.2 kg/ha were tested against adult grass grub (*Costelytra zealandica*) during the mating flight period. The trial was designed to determine the accuracy required for the timing of insecticide applications in order to attain maximum grass grub control. The mating period was estimated from mating flight activity and soil coring information collected from the trial site over the previous two flight seasons, and agreed well with mating flight activity measured during the trial period. There was a trend to less effective control as the commencement of the spray programme moved away from the *ideal* time. The *ideal* spray programme gave 95% control compared to 77% for a programme started 8 days late ($P < 0.05$)

INTRODUCTION

When Fenemore (1964) mentioned the possibility of insecticidal control of adult grass grub, he recognised that correct timing of the treatment would be essential; the beetles must be killed before mating and oviposition occur. However, at that time the exact relationship between grass grub development, emergence, flight, mating and oviposition was not well understood. In addition, it was not known if the mating period on a particular site occurred at the same time from year to year, nor if there was uniformity from site to site within regions.

East (1972) reported that primary emergence usually occurred 6-10 days after adult eclosion. Henzell and Kain (1972) and Henzell and Lauren (1977a,b) showed that up to 80% of female beetles can be mated within the first 10 days of major mating flights. Once mated, females generally do not re-emerge before oviposition (W. M. Kain pers comm). Consequently, to treat beetles effectively, and to obtain maximum effect, the insecticide must be applied before the commencement of mating flights, and must retain residual activity over the entire mating period.

Recent publications (Henzell and Lauren 1977b,c; Pottinger *et al* 1977 1978) have shown that good control can be achieved using synthetic pyrethroids against grass grub adults. The former authors used sex attractant traps to monitor grass grub flight at their trial site the previous spring, and applied the insecticide over the major mating flight period determined from this information. Flight information during their trials confirmed the dates of the mating flight period, and they achieved over 90% control with two or three applications of cypermethrin at 0.25 kg/ha, spaced to maintain a toxic cover over the pre-determined period. The latter authors used sex attractant traps to measure flight activity in the year of the trials only. Using three applications of cypermethrin at various

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rates between 0.075 and 0.6 kg/ha, they reported from 50-94% and from 46-78% control in 1977 and 1978 respectively.

Because of the difficulty of predicting the advent of the major mating period from measurements made within the season of interest, Henzell *et al* (1978) commenced a programme to measure the extent of variation from site to site of the occurrence of the major mating flight period, and also, to confirm if the periodicity of major mating flights is consistent on most sites from year to year. In line with these aims, work described in this paper attempts to determine how much room there is for error in the timing of a pyrethroid spray programme against grass grub adults. We have combined this aim with a comparison of two rates of each of two different pyrethroids, and with a comparison of the relative effectiveness of two-spray programmes and three-spray programmes.

METHODS

Pre-treatment

The trial site was on a dairy farm 30 km south of Hamilton. The site was on a flat area partly used for grass grub trials in previous years (Henzell and Lauren 1977a,b,c).

Eighty four 9 x 9 m plots were placed in rows in two adjacent paddocks, with at least 3 m between any two plots. In September, 1977, 36 soil cores (Kain and Young 1975) (10 cm dia.), taken in a random grid pattern from the inner 5 x 5 m of each plot, gave plot populations of 21-205 larvae or pupae/m². The plots were blocked with respect to population, with three replicates per treatment in each paddock. Both paddocks were grazed up to October 15, 1977, and had a pasture height of 3-6 cm at the commencement of the spray programme.

Monitoring

Grass grub mating flight activity over the trial area was monitored using a monitoring kit (Henzell *et al* 1978), with traps placed at least 15 m from all plots.

Treatments

A summary of treatments showing insecticides, rates, timing of first applications, and spray intervals is shown in Table 1.

The grass grub mating flight activity recorded at the trial site in three consecutive years is shown in fig. 1. The 1975 and 1976 information allowed the major mating period to be determined as occurring between October 21 and November 8, and this is in agreement with flight information obtained in the 1977 season (the cumulative percentage catch increased from about 10% to 80% in this period). This, combined with the fact that 100 g/ha of cypermethrin and *ca.* 200 g/ha of permethrin maintain a reasonable contact activity on pasture for about 6 days (R. F. Henzell, D. R. Lauren and G. D. G. du Toit, unpublished information), allowed the *ideal* spray programme (treatment 4) to be defined as one commencing on October 21, with three applications at 6 day intervals. This would maintain a toxic coverage on the foliage from October 21 to November 8, as shown by the solid vertical lines in fig. 1. The second and third spray dates are indicated by broken vertical lines. The timing effect was examined using similar programmes of three applications starting earlier treatments 1, 2, 3) or later (treatments 5, 6) than the *ideal*.

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FIG. 1: Grass grub mating flight activity on the trial site as measured with sex attractant traps.

Chemicals and equipment

Cypermethrin was supplied as an emulsifiable concentrate containing 250 g/litre. Permethrin was supplied as an emulsifiable concentrate of 500 g/litre. Both formulations were supplied by ICI Plant Protection Division, Jealott's Hill Research Station, Bracknell, England.

Applications were made using a modified hand-held Oxford sprayer fitted with Teejet 8004 nozzles. The boom (3 m) was pressurised to 200 kPa with dry nitrogen. The insecticide was applied in 300 litres/ha. Treatments were generally applied to dry foliage in the morning of application days. This avoided much wind interference.

Post-treatment

Both paddocks were cut for silage on November 16, 1977. After a further 3 weeks, one paddock was grazed (12 h) by the dairy herd (80 cows/ha) on a 14 day rotation. The other paddock was grazed (12 h) once by the dairy herd (85 cows/ha) 3 weeks after ensilage, then, after a further week, grazed exclusively by calves (21/ha).

Treatment effects were assessed in March, 1978, by taking 49 soil cores in a random grid from the inner 5 x 5 m of each plot. It was obvious at this time that the laxly grazed calf paddock had more pasture cover than the other paddock.

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RESULTS AND DISCUSSIONS

All treatments (Table 1) gave a significant reduction in the subsequent larval population ($P < 0.01$). At roughly cost-equivalent rates (permethrin rate = 2 x cypermethrin rate) there was no significant difference between insecticides ($P > 0.1$). For *ideal* three-spray treatments, (4,7,11,12), the lower rates of both chemicals were less effective ($P < 0.01$) than the higher rates. The reduced level of control achieved with these lower rates indicates that they are close to the lowest practical limit for each chemical.

TABLE1: Summary of treatments and resulting reductions in the subsequent grass grub larval populations.

Treatment number	Chemical and rate (kg/ha)	First spray date	No. of sprays	Spray interval (days)	Control* (%)
cypermethrin at					
1	0.1	Oct 17	3	6	90
2	0.1	Oct 17	3	8	88
3	0.1	Oct 19	3	6	93
4	0.1	Oct 21	3	6	95
5	0.1	Oct 26	3	6	85
6	0.1	Oct 29	3	6	77
7	0.05	Oct 21	3	6	76
8	0.1	Oct 21	2	6	76
9	0.1	Oct 21	2	8	82
10	0.1	Oct 21	2	10	77
permethrin at					
11	0.2	Oct 21	3	6	89
12	0.1	Oct 21	3	6	74
13	0.2	Oct 21	2	6	72
14	untreated	-	-	-	0

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

For both insecticides, two-spray treatments (8,9,10,13) were less effective than three-spray treatments (4,11) ($P < 0.01$), with no significant differences between the different spray intervals ($P > 0.1$). This suggests that foliage under treatments 8 and 13 lost contact activity before the end of the mating period. Foliage under treatment 10 probably lost contact activity 2 or 3 days before the second spray, but then retained activity for the remainder of the mating period. The optimum interval between sprays will often vary for different chemicals, formulations and rates used, and the level of control achieved with the two-spray programmes could probably be improved with formulations (Henzell and Lauren 1978) or chemicals that have a greater field biological life.

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The overall effect of changing the initiation date of three-spray programmes away from the *ideal* was only weakly significant ($P < 0.1$), but the pattern of results was in accordance with the expected trend. Of particular interest was the comparison of treatments 3 and 4 with the late treatments 5 and 6. The differences in the level of control achieved were significant ($P < 0.05$), with a delay of 8 days from the *ideal* reducing the level of control from 95% to 77%. The implications of these results are important. In the extreme, gross mistiming of the spray programme would cause failure of the technique, and Henzell *et al* (1978) have shown that in the Waikato region alone, the initiation of major grass grub mating flights was spread over nearly 4 weeks, with differences of up to 1-2 weeks between some sites only a few km apart (unpublished information used in previous reference).

Further work is required to determine how accurately timed spray programmes must be to give consistently high reductions in grass grub numbers. Timing effects may be more important in some years than in others. For example, in 1976 few mated females were present at the trial site before October 29 (Henzell and Lauren 1977 b,c), and any late-start spray programmes starting before this date would have been expected to give a reasonable reduction in grass grub numbers. However, in 1975 about 80% of the females had mated by October 29 (Henzell and Lauren 1977 a,b), and presumably a spray programme delayed until this date would have given limited control.

A marked difference in grass grub larval numbers between the two paddocks was noticed at the post-treatment sampling. The population in the more heavily grazed paddock was about 70% less than in the laxly grazed paddock. This is consistent with stocking rate effects observed previously (Dixon and Campbell 1978; East 1978). Heavier grazing pressure over the 1978 summer drought gave a reduction in grass grub numbers almost equal to that obtained in the more lightly grazed paddock with the less effective, insecticide treatments. However, the residual population (23 larvae/m²) was of sufficient magnitude to increase rapidly under favourable conditions (Kain 1972). The added effect of the *ideal* spray programme reduced the population to 2.5 larvae/m², a population that would take several years to reach damaging numbers (Fenimore 1964; Kain 1972). In the laxly grazed calf paddock, the optimum treatment reduced the grass grub larval population to about 6.5/m², compared to 135 larvae/m² in untreated areas.

CONCLUSION

The two synthetic pyrethroids have proved very effective against grass grub adults at low rates, and results indicate that in some seasons at least they can tolerate quite severe user errors in timing and still give reasonable control. The timing effect is not too critical to make adult control impractical, and thus small within-farm differences could be accommodated. Care to ensure that the spray programme is timed to obtain maximum effect could mean that several years control would be obtained from one treatment. The need for accurate timing is a situation enforced by the short active life of the pyrethroids, and the associated need to keep the number of applications to a minimum.

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REFERENCES

- Dixon, G. M. and Campbell, A. G., 1978. Relationships between grazing animals and populations of the pasture insects, *Costelytra zealandica* (White) and *Inopus rubriceps* (Macquart). *N.Z. J. Agric. Res.* 21: in press.
- East, R., 1972. Starling (*Sturnus vulgaris* L.) predation on grass grub (*Costelytra zealandica* [White], Melolonthinae) populations in Canterbury, N.Z. Unpubl. PhD thesis, Lincoln College Library, University of Canterbury. 473 pp.
- East, R., 1978. Effects of grazing management on grass grub populations. *Proc. 2nd Australasian Conf. of Grassland Invertebrate Ecology*: in press.
- Fenimore, P. G., 1964. Prospects for alternative chemical methods of grass grub control. *Proc. 17th N.Z. Weed and Pest Control Conf.*: 135-40.
- Henzell, R. F. and Kain, W. M., 1972. Field trials with phenol for grass grub control. *Proc. 25th N.Z. Weed and Pest Control Conf.*: 263-7.
- Henzell, R. F. and Lauren, D. R., 1977a. The use of sex attractant traps to estimate the development stage of grass grub, *Costelytra zealandica* (White) (Coleoptera : Scarabaeidae), in the soil. *N.Z. J. Agric. Res.* 20: 75-8.
- Henzell, R. F. and Lauren, D. R., 1977b. Grass grub control through sex attractant and insecticide combinations. *Proc. 29th Ruakura Farmers' Conf.*: 20-3.
- Henzell, R. F. and Lauren, D. R., 1977c. Control of grass grub adults with synthetic pyrethroids. *Proc. 30th N.Z. Weed and Pest Control Conf.*: 211-6.
- Henzell, R. F. and Lauren, D. R., 1978. Contact activity of synthetic pyrethroids against adult grass grub, *Costelytra zealandica* (White). *Pestic. Sci.*: in press.
- Henzell, R. F., Lauren, D. R. and Cox, N. R., 1978. Monitoring grass grub flight with sex attractant traps. *Proc. 2nd Australasian Conf. of Grassland Invertebrate Ecology*: in press.
- Kain, W. M., 1972. Problems in controlling grass grub. *Proc. 24th Ruakura Farmers' Conf.*: 109-20.
- Kain, W. M. and Young, J., 1975. Population studies of *Costelytra zealandica* (White). 1. A soil sampler suitable for sampling pastureland. *N.Z. J. Exp. Agric.* 3: 177-80.
- Pottinger, R. P., East, R., Welsh, R. D., Stratton, A. E. and Maxwell, B. C., 1977. Evaluation of cypermethrin for control of adult grass grub. *Proc. 30th N.Z. Weed and Pest Control Conf.*: 217-21.
- Pottinger, R. P., Welsh, R. D., East, R. and Stratton, A. E., 1978. Control of grass grub adults with cypermethrin. *Proc. 2nd Australasian Conf. of Grassland Invertebrate Ecology*: in press.