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PLOUGH AND CORE ASSESSMENT OF BLACK BEETLE INSECTICIDE TRIALS

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Summary

The precision and time efficiency of the single furrow plough technique for assessing black beetle (*Heteronychus arator*) populations were compared with the standard core technique in an insecticide trial. The plough technique worked well on heavy clay and light sand soils, and on ryegrass (*Lolium* spp) of Kikuyu grass (*Pennisetum clandestinum*) dominant swards. The plough technique was 4-fold (sand) and 6-fold (clay) more time efficient than the core technique. The greater precision of the plough technique was demonstrated by an analysis of treatment comparisons, which showed much higher levels of significance using the plough data than was the case with core data.

INTRODUCTION

The effectiveness of insecticides against black beetle has usually been assessed by hand-sorting 10 cm diameter soil cores taken with a coring device originally developed to estimate grass grub (*Costelytra zealandica*) populations (Kain and Young 1975). The core technique is very laborious. This contrasts with the single furrow plough technique, originally developed for assessing Australian scarab populations (Roberts and Ridsdill Smith 1972), which is more efficient than handsorted 20 cm spade squares for obtaining accurate population estimates of grass grub and porina (*Wiseana* spp) (Kain *et al* 1978).

A large number of candidate insecticides and insecticide application techniques for the control of black beetle have been screened using small plot trials and the soil core technique (Watson and Webber 1976; Blank and Olson 1978). The best of these insecticide treatments are currently being evaluated using field scale applicators on larger sized plots. The plough assessment technique has been used to evaluate these trials. The aim of this study was to compare the precision and time efficiency of the single furrow plough with the core assessment technique. The insecticide evaluations will be dealt with in another paper.

METHODS

Sites

Insecticides were applied to the pasture in early December 1978. A randomised block design was used with four replicates at two sites. The Whangarei Heads site was a flat hay paddock on a heavy Hihi clay soil. The dominant grass components of the sward were ryegrass (70%) and patches of Kikuyu grass (30%). The Dargaville site was a northerly sloping paddock on a light friable Red hill sand and the pasture comprised Kikuyu grass

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(60%) and ryegrass (40%). The assessment areas (4.5 x 13 m) were taken from the centre of each insecticide treated area and untreated control plots.

Core technique

The 15 kg soil corer described by Kain and Young (1975) was thrown into the soil. The depth of the 10 cm diameter soil core thus taken varied according to the friable nature of the soil (e.g., 15 cm in Red Hill sand and 12 cm in Hihi clay). Each soil core was released from the soil corer either into a plastic bag to prevent the loss of the mobile black beetle stages or directly onto a metal tray where it was sorted. Twenty soil cores were taken at regularly spaced intervals within the assessment areas of each plot in late February. The number of men used and the time taken to core and sort the 20 cores /plot, including replacement of soil, were recorded.

Plough technique

The single furrow mould board plough used was pulled by a small hand-operated tractor with a 4.5 kw motor and was similar to that described by Roberts and Ridsdill Smith (1972). The two coulter cut a 14 cm strip of turf which was then removed by the ploughshare and turned upside down beside the furrow. A 4.5 m length of furrow was turned at any one time so that the black beetle exposed in the furrow and on the overturned turf could be counted before they had time to rebury in the soil. The optimum depth setting of the plough was determined at both sites by comparing black beetle counts from six furrows taken from each of the control plots at a shallow and deep setting. All plough assessments were then run at the depth setting which exposed the greatest numbers of black beetle.

The relationship between the numbers of black beetle exposed by the plough and the numbers actually present in the soil was obtained by hand-sorting 1 m sections of the overturned turf and the bottom of the furrow to a depth of 15 cm. Twenty calibration counts over as wide a range of furrow densities as possible were assessed in this way from the control plots at both sites.

For the insecticide assessment, 12 furrows were run at metre intervals across the line of insecticide application in the assessment area of each plot in late February. The number and stage of black beetle exposed were recorded for each furrow. The number of men used and the time taken to assess each plot, including the replacement of the turf back in the furrow, were recorded.

RESULTS AND DISCUSSION

Plough technique

The single furrow plough worked well on both the Red Hill sand and Hihi clay. Rain had fallen at both sites during the week preceding assessment and this raised the soil moisture levels appreciably to 24% on the Red Hill sand and 30% on the Hihi clay which aided ploughing. The Hihi clay turf remained intact during ploughing whereas the light Red Hill sand turf often broke apart. Furrows were more easily turned on ryegrass than Kikuyu grass swards. In some instances more traction was needed to turn a furrow in the Kikuyu swards. This was easily done by balancing extra weight (usually one of the 'assessors') from the front end of the tractor and increasing ploughing speed. Larger coulters than those provided on the original plough apparatus (16 cm diameter) would give a more effective cut of the underground Kikuyu grass stolons, particularly at the 6-8 cm depth used on the Red Hill sand.

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Minor errors in furrow counts undoubtedly occurred; e.g., losses due to black beetle falling off the turf onto the pasture and disappearing from sight before being counted as well as gains due to broken turf. However, such errors in furrow counts are of little consequence when comparing treatments provided that errors do not influence one treatment relative to another. The method of counting all black beetle exposed, ignoring possible losses and/or gains, was justified as at both sites the ratio of number per furrow to number per core was similar on the high population plots (control) and on the low population plots (treated).

There was a marked increase (1.5 - 2.0 fold) in total black beetle counts at the deeper furrow depth used at both sites (Table 1). All black beetle stages were found in greater abundance from the deeper furrows with pupae showing the greatest increases.

Table 1. The effect of the plough depth setting on the number and stages of black beetle recovered from 108 m length of furrow in control plots.

	Furrow Depth (cm)	Third instar	Pre- pupae	Pupae	Teneral Adults	Adults	Total
Red Hill sand	2-4	47	2	6	4	10	69
	6-8	61	9	21	6	14	111
Hihi clay	2-3	1	1	1	14	5	22
	4-5	4	2	14	22	8	50

Attempts to obtain absolute population estimates using the plough technique by establishing calibration curves, as described by Roberts and Ridsdill Smith (1972), were unsuccessful. When a furrow count of 2 black beetle can give a calibration count ranging from 2 - 11 beetles the poor correlations obtained were not unexpected. Such population estimates using these calibration counts were considerably lower than estimates using core counts. The erection of calibration curves for each black beetle stage as suggested by Roberts and Ridsdill Smith (1972) would still not resolve this problem because of the wide range of depths at which these different stages may be found (Table 1). Calibration of the plough has yet to be tested in January when only larval stages are present or after April when the black beetle population is comprised largely of over-wintering adults.

Damage to the paddocks from the plough furrows was slight and the autumn regrowth obliterated any sign of the furrows within 2 months.

Precision and time efficiency of plough versus core techniques

The distribution of counts for both cores and furrows followed the Poisson distribution and hence the spatial distribution could be regarded as being random (within plots). Assuming a random distribution, the only criterion for comparing two sampling methods is the number found per unit of time-effort, i.e., the method that finds the most is best. The mean assessment times using a five man team were 1.4 and 1.5 man minutes per core compared with 4.2 and 2.5 man minutes per furrow for Red Hill sand and Hihi clay respectively. Furrows took longer to assess on the Red Hill sand because of the greater black beetle numbers and the uneven terrain, as well as the high proportion of Kikuyu grass and broken turf. Cores of Red Hill sand were easier to break up and sort for black beetle than the Hihi clay cores. The plough technique exposed 7.4-fold (Red Hill sand)

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and 6.2-fold (Hihi clay) more black beetle than did the core technique (Table 2). After adjusting for time differences, the number of black beetle found in the furrows per unit of time was 4-fold (Red Hill sand) and 6-fold (Hihi clay) the number found in the cores per unit time.

The greater precision of the plough technique is revealed by the analysis of treatment comparisons which show much higher levels of significance using the plough data than was the case with the core data (Table 2). Coring was a waste of time in comparison to ploughing.

Table 2. Black beetle numbers assessed by the plough and core techniques.

Treatment	Rate kg/ha	Red Hill Sand		Hihi Clay	
		Plough	Core	Plough	Core
untreated		190	28	108	20
fensulfothion broadcast	2	9	0	31	7
fensulfothion broadcast	1	59	7	40	4
isazophos broadcast	2	7	1	30	1
isazophos broadcast	1	7	1	43	11
isazophos jet squirt	2	53	6	38	7
isazophos jet squirt	1	80	12	59	6
Significance of treatment differences:					
Chemical		P<0.001	P<0.05	ns	ns
Rate		P<0.01	P<0.1	P<0.1	ns
Chemical x rate		P<0.05	ns	ns	ns

This comparison of core versus plough data analysis illustrates the recurring problem encountered by research workers in deciding on the degree of sampling effort within plots versus more plots (i.e, replicates). Generally, it is better (statistically) to go for more replicates and less sampling within replicates provided that a "reasonable" estimate for each plot is obtained. In this case it can be seen that the core data (for 4 replicates) gave a generally unsatisfactory within plot estimate; whereas the plough data gave a very reasonable within plot estimate.

CONCLUSIONS

The Plough technique has a 4 to 6-fold time efficiency - precision advantage compared to the core technique. Low black beetle populations can thus be more readily assessed using the plough than with the core technique. The requirements of individual physical strength so necessary in successful coring teams is nullified by using the plough to do all the hard work. Operator fatigue is considerably reduced enabling longer hours to be worked more efficiently. The plough technique is most suitable for comparing the effect of various treatments on black beetle populations (e.g., insecticide trials) where absolute population estimates are not required. If an absolute measure of the black beetle population /m² is required the advantage of the plough is reduced. A good strategy to enable estimation of absolute populations and still maintain the benefits of the plough technique would be to assess all plots with the plough and then take cores in the control plots only. The plough technique may than be useful in survey work and in seasonal monitoring of black beetle populations. The core technique will still have to be used to prevent damage to plots or on difficult terrain.

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