CLOVER CASE-BEARERS IN NEW ZEALAND

A Review of the Problem with Special Reference to Control

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Summary

The literature to date on control measures for clover case-bearers is reviewed, followed by a brief description of present-day chemical, biological and managerial controls. The economic significance of damage when growing white clover (*Trifolium repens*) seed is also discussed. It is concluded that insecticides should only be used if economically necessary and that their use should be kept to a minimum.

INTRODUCTION

Lindsay (1927) first recorded the occurrence of a coleophorid case-bearer on clover in New Zealand, his material being collected at Governor's Bay near Christchurch in 1922. There are two species of clover case-bearers attacking white clover (*Trifolium repens*) crops. Hamilton (1944) recorded one of the species as *Coleophora spissicornis* Haw. Later Dumbleton (1952) recognized the presence of two species and tentatively determined the other as *C. frischella* L. When a parasite search was instituted in Europe, it was determined that *C. frischella* was largely an inhabitant of *Lotus* spp. and formed a case quite unlike either New Zealand species. In 1957, Stuart published a correction, naming the previously determined *C. frischella* as *C. alcyonipenella* Koll. Recently, Bradley (1967) recognized that the name *C. frischella* had been misapplied to a species which he now refers to as *C. trifolii*. *C. frischella* is now applied to the New Zealand species which had been known as *C. alcyonipenella.*

In 1965 the value of white clover seed produced in New Zealand was $5,000,000 (Anon., 1966.). Dumbleton (1959) reported that damage to white clover in South Canterbury in one season ranged between 10 and 15%; Kelsey (1958) estimated that the overall damage to set seed could be as high as 63%.

In 1959, Dumbleton made the depressing observation that "no control measures can so far be recommended", this statement being based on lack of success in control of larvae. Hoy (1960) demonstrated that toxaphene sprayed during flowering (against the adult) increased white clover seed yields approximately five-fold. As a result, DDT and toxaphene were widely used at approximately 1 l/ha (Dumbleton, 1963). These materials were not used with confidence because of their deleterious effect on honey-bees, despite the fact that experiments indicated that use of these materials was safe provided they were applied when bees were not working the crop (Palmer-Jones *et al.*, 1958). Dumbleton (1963) demonstrated that improved control was obtained if DDT was sprayed twice, once at moth peak and again 10 days later. DDT and toxaphene were used for several years, until prohibited in 1967. During this period, experiments were being conducted using alternative shorter-lived organophosphate insecticides (Dumbleton, 1964; Allen, 1965, 1966; Leonard, 1965; Proude, 1966). A number of materials, including diazinon and phenthoate, were found lethal to moths but were unacceptable because of their toxicity to bees (Clinch *et al.*, 1966). Finally, trichlorphon emerged as a safe, relatively effective material (Proude, 1966). It was widely used, but with variable results, until superceded by bromophos and dichlorvos, both of which are more consistent and effective (French, unpubl. data) but relatively harmless to bees if applied at the correct rates and when bees are not present on the crop (Palmer-Jones and Clinch, 1968).

These insecticides should be applied at the recommended rates (see French, 1971), preferably on calm, warm evenings when moths fly in large numbers. The efficiency of the recommended insecticide is enhanced by evening application. This ensures that the volatile insecticides are held longer on the crop before rising day temperatures and wind reduce their effectiveness. Furthermore, in the evening the risk of high bee mortality is minimized.

CONTROL MEASURES

Chemical

The most commonly used chemical method is aimed at adult moth control by application of a suitable material when bees are not working the crop. Unfortunately, there can be little doubt that, at times, spraying is conducted with a disregard for the safety of bees and other beneficial insects. This, coupled with a relatively high cost of materials, is a far from satisfactory situation. Even when correctly applied, some damage to honey-bee colonies does occur. When correct timing of application is disregarded, a reduction of seed set greater than that normally due to case-bearers' depredations would occur because of the elimination of essential bee pollinators. For this reason, chemical control should be resorted to only after adequate assessment of moth populations in relation to white clover flower-head numbers (French, 1971).

Biological

For some years, Entomology Division of DSIR has been actively engaged in a coleophorid parasite introduction programme. So far, two parasites have been released. One (*Bracon variegator*) showing promise of success is now well established in the Nelson district. This parasite has been established in the Lincoln area (T. Jessep, pers. comm.) but recoveries have not been made in other release areas such as the Waikato.

Managerial

Dumbleton (1963) pointed out that, while no consistent pattern of infestation occurs, the tendency is for first-year clover crops to suffer less damage than in their second year.

He also noted that pre-harvest paddock history, particularly relative to stock density and related trampling, may affect subsequent infestations. A survey carried out in 1964 (French, unpubl. data) indicated that rotational mob-stock grazing during the pre-harvest winter could bring about some reduction in first brood damage.

Dumbleton (1964) suggests that any white clover flowering in the season prior to the first clover seed harvest should be suppressed to avoid early build-up of case-bearer populations. In most cases, it can be assumed that seed loss resulting from case-bearer damage will be higher in the second than the first clover year and it is therefore advantageous to aim at maximum seed production in the first year of seed harvest.

ECONOMIC SIGNIFICANCE

The growing of white clover as a seed crop always has and always will be a risky venture. Apart from weather and management, there are many biotic factors involved, of which case-bearers is only one. Apart from irrigation, little can be done to counter vagaries in weather conditions but, in relation to other factors such as grazing management, fertilizer programming, weed control, bee management, harvesting and dressing techniques, the skill, judgement and industry of the grower have a marked influence on the ultimate value of the crop. It has been shown, for example, that, in a particular crop survey, only 48% of available mature seed set was in fact harvested and the implication of this relates only to the efficiency of harvesting techniques. Improvement in this mechano-technical area could well result in better seed yields than would total elimination of case-bearers.

In Canterbury, case-bearers account for only about 9% of the potential seed yield (French, unpubl. data).

There is certainly considerable advantage in integrating management methods with knowledge of case-bearer moth behaviour in the field. If seed production is based solely on maximum first-year clover crop yields, losses by case-bearers would be minimized. Following crops could then be utilized only for grazing or hay.

Alternatively, a cereal crop, undersown with white clover, could be used each year.

RECOMMENDATIONS

(1) Insecticides should be applied against moths only when the standard technique for assessment of population size in relation to flower-head density indicates economic necessity.

(2) In some situations, biological control by *B. variegator* may remove the necessity for the use of insecticides.

(3) Managerial control as such is inadequate except when related to harvest of first-year crops rather than second.

(4) To improve seed yields, crop management and harvesting techniques appear to be more important than control of case-bearers.

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GRASS GRUB

CHAIRMEN'S SUMMARIES

PART 1

D. D. McPhail
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In the first part of the session, the papers by R. B. Gordon and W. M. Kain and by W. M. Kain and D. S. Atkinson, which had an economic approach, were discussed separately. The data on the effect of grass grub on animal production and financial returns were valuable. The most significant point to emerge was the drastic effect of attack in the central plateau area where there is little reserve in fertility and soil stability. In this area of low grass productivity and a soil favourable to grass grub, the need for more extensive use of species such as lucerne for resistance to both drought and grass grub was stressed. Whether pastoral farming is the best land use for that area was also questioned. In the seasons involved in the Takapau work rainfall was above average, providing favourable conditions for pasture recovery; production in spring/summer could be drastically reduced if a drought stress was added to the grass grub effect.

W. M. Kain and R. Crabtree highlighted the need for more accurate distribution of such transient materials as fensulfothion, particularly on hill country. Mr McLean stated that accuracy can be improved by using parallel, overlapping passes, rather than passes at right-angles. Equipment for sowing low rates of seed in forestry work was reported. Improved effectiveness of aerial control on hill country is important and further work on this and on insecticide formulations, is needed. It was also stressed that the number of grubs remaining is more important than the percentage killed.

R. F. Henzell and W. M. Kain evaluated the use of phenol to upset flight and mating patterns. This is an alternative to attracting the beetles to a lethal trap, and offers some promise as an additional factor in a total control approach.

A further contributing factor is bird predation as described by R. East and R. P. Pottinger. It was stressed in discussion that the results could not fairly be extended beyond the particular circumstances which involved high grub populations, irrigation, high stocking rates and a high starling population. It was also reported that a significant bird predation observed at Dannevirke did not occur until the damaged areas were obvious and the turf breaking down which facilitated bird feeding. Also discussed were the feeding requirements for starlings during the period when grass grubs were not available, but no extensive information was forthcoming.

E. A. Upritchard *et al.* included details on methods of application being used by farmers and discussed the factors affecting results. The relative importance of soil moisture at time of treatment and subsequent rainfall has not been accurately defined and future trial work should consider these factors. Discussion again included reference to the improved insecticide distribution where overlapping, parallel passes were made either by aircraft or ground equipment. The accuracy of applying insecticide through irrigation equipment was questioned and the authors stated that the experience from the Leeston area was very limited.

GRASS GRUB

PART 2

P. G. FENEMORE
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K. M. Stewart and S. M. J. Stockdill confirmed the two-year life-cycle of grass grub in parts of the South Island. Its cause was raised in discussion and Dr Stewart thought it was probably a temperature effect. No data were available as to the situation in the central North Island. The optimum time for insecticide application in a two-year life-cycle situation has not yet been determined.

O. R. W. Sutherland showed how simple techniques had been put to good effect in investigating the attraction of grass grub larvae to plant roots and the chemical stimuli required for their feeding. Although the paper concerned only ryegrass in larval attraction studies, a range of other plants had been examined. Lucerne was particularly attractive but was unsuitable as a food source and in fact appeared to be pcsitively antibiotic.

Progress in rearing procedures were reported in the first of J. A. Wightman's papers. In investigating food materials, the useful observation had been made that some plants, especially legumes, were positively deleterious. This had been utilized by growing peas as a treatment in a cultivation experiment reported in the second paper. Time precluded any significant discussions of these two papers the value of which would have been greater had the subject matter been restricted to rather narrower topics.

The review of procedures in field trials presented by P. C. Palmer and J. G. Tattersfield filled a very useful function. Because of the large time and manpower commitment to such work, any improvement in efficiency which may be obtained from such a review is welcome. The question was asked as to whether any transformations of counts other than those reported had been tried. Transformation generally was not considered to be of benefit. Mr Kain pointed out that most distributions of grass grubs were strongly skewed. Perhaps one of the most important points made in this paper was that "often an attempt is made to answer too many questions in the same trial". The chairman commended this thought to members as being a temptation into which it is easy to fall.

CORRECTION: During discussion some errors in Table 4 on page 236 were pointed out. The centre columns should read:

Intercept	*Slope*
3.33 ± 0.014	—2.1 ± 0.5
3.76 ± 0.020	—2.2 ± 0.4
2.91 ± 0.16	—5.8 ± 1.4
4.77 ± 0.04	—5.4 ± 0.7
8.39 ± 0.08	—31.0 ± 3.3
8.61 ± 0.21	—17.7 ± 3.3
2.45 ± 0.18	0.28 ± 0.08
2.33 ± 0.33	0.27 ± 0.09
—2.87 ± 1.94	3.5 ± 0.8
—3.29 ± 2.39	2.4 ± 0.6
11.37 ± 0.08	—10.6 ± 3.0
14.72 ± 0.20	—8.6 ± 3.0

Pasture production in kg × 10^3/ha. Grass grubs in $10^3/m^2$.