BIOLOGY AND CONTROL OF THE CLOVER CASE-BEARER

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Summary

Control measures for clover case-bearer (*Coleophora* spp.) are directed against the moths. Under average Canterbury conditions with the harvest in late January most of the seed loss is due to the larval progeny of the first brood moths, and a single spray applied at their peak (end of November) may prevent about half this loss. DDT at 1 lb/ac has given an immediate kill of moths in excess of 95%, and increased seed yield from 400 to 460 lb/ac. If its use is prohibited trichlorfon is at present the only insecticide which is known to present no residue problem, have no adverse effect on bees, and approach DDT in toxicity to moths and in cost. If the harvest is late the effect of control of the first brood may be obscured by the damage done by the larger second brood which has a peak after mid-January.

THE LARVAE of two European species of *Coleophora* (Lepidoptera-Coleophoridae) damage white clover seed in the field in New Zealand. Little or no information is available on the economic status and control of these two insects in Europe or in Australia and California where one or both are established. The following account is based on observations in Canterbury and may not apply in detail elsewhere.

BIOLOGY AND SEASONAL HISTORY

The moths of both species are $\frac{1}{4}$ in. long, dark in colour, but with a brassy sheen in some lights. The wings are folded closely to the body and the insect appears to be relatively long and narrow. The adults of *C. spissicornis* may usually be recognized by the much thicker basal half of the antennae and the black and white banding of the apical half.

In Canterbury, the moths of first brood of *C. alcyonipennella* are flying from late October to late December, the peak of numbers being about the end of November. Moths of the first (and only) brood of *C. spissicornis* are flying from mid-November to early January, with a peak about mid-December. In late December, few moths are present but the numbers increase rapidly in January because of the emergence of the moths of the second brood of *C. alcyonipennella*, which has a peak at or after mid-January. Moths may be present in early April and these are probably late stragglers of a third brood.

The moths may live 1 to 2 weeks and the female may lay 90 eggs. These are placed, usually singly, in the open florets of the clover heads and hatch in about 10 days. The small larvae feed on the young green seeds in the floret in which they hatch but later move to other florets and, when larger and enclosed in the brown, $\frac{1}{4}$ in. long, cigar-shaped case they may migrate to other clover heads. The larvae take about 6 weeks to become fully fed. Those of *C. spissi-*

cornis pass the winter without pupating but those of *C. alcyonipennella* pupate within the case which is attached to the clover head, and in about 12 days the moths of the second brood emerge. Moths of the second brood may be several times more numerous than those of the first. The third brood is probably smaller. Some of the first brood, many of the second and all of the third brood larvae hibernate in their cases throughout the winter on the soil surface. From mid-September onwards, the cased larvae become active, move upwards on the plants, attach their cases and pupate within them — the first brood moths emerging in late October.

DAMAGE TO SEED AND SEED LOSSES

Coleophora alcyonipennella is considered to be the more injurious of the two species since *C. spissicornis* has only one brood and is usually present in smaller numbers.

If a new pasture is sown in autumn shortly after the old pasture is broken up, the case-bearer infestation may originate from overwintering larvae which survive the cultivation. If the field is broken out of old pasture in spring and is fallow, or at least has no flowering clover, during summer, any subsequent infestation must originate from immigrant moths. If flowering clover is present in the first summer (ryegrass harvest), the infestation can establish then, and will tend to build up and be greater in the second white clover crop than in the first. The rate of build-up will be influenced by the management of the pasture — e.g., whether it is grazed continuously, or, if shut up for seed, the date of harvesting. Variations in pasture management practice probably account for the wide range in the degree of infestation between fields.

Seed losses must be correlated with the number of larvae in the crop, and with the numbers of moths in the brood which gave rise to them. This is most evident when the harvest date is early enough to prevent damage by the second brood. The size of the first brood moth population is determined by the number of larvae going into hibernation in the previous autumn, and the mortality amongst them during the winter.

If, because of the lateness of harvest, the seed is exposed to damage by the (usually much larger) second brood, there may be no evident correlation between the seed losses and the size of the first brood.

The amount of seed set influences the percentage damaged by a moth population of given size — the smaller the seed setting the larger the percentage damaged. The time of the main flowering in relation to the peak of the moth flight, and the proportion of the later-flying *C. spissicornis* in the combined first brood moth population, must also influence seed loss.

The percentage of damaged seed is most readily estimated on samples of large seed. It is difficult to estimate the loss of very small seed because the remains of these, which are small, fragile and light, are lost in dressing. Seed losses estimated from increases in seed yield following insecticidal treatment are subject to error in that it is not known how much of the damage is prevented by the treatment. Even in cases where all the damage is done by the first brood, a single spray applied at the peak of moth flight cannot kill more than half the total first brood moths. Hence, if untreated clover yields 400 lb of seed per acre and one treatment increases this by 60 lb, it is probable that complete control of the moths would have increased the yield by 120 lb, which indicates a loss of 23% on a potential yield of 520 lb/ac.

CONTROL

The case-bearer would appear to be a promising subject for biological control and attempts to introduce parasites have been in progress for some time.

It is not possible to make definite recommendations as to pasture management practices which would reduce seed losses. There is a suggestion that suppression of white clover flowering in the rye-grass year would delay the build-up of the insect in the field. Heavy stocking in winter probably reduces the overwintering population of larvae by trampling, and heavy stocking and late shutting-up in spring may reduce the population of larvae and pupae by both trampling and grazing.

Chemical control measures, especially if they are relatively cheap, may be employed purely as an insurance, without knowledge of the necessity for them or the results obtained from them. Many factors affect seed yields in white clover. In some cases they are likely to be low because of poor seed setting and the use of insecticides can do nothing to remedy this. The size of the first brood moth population is the only practicable index of the necessity for treatment, since seed losses due to the first brood are directly correlated with it. The information available suggests that, when the mean moth population (based on a number of counts, each of 20 sweeps with a 10 in. diameter net) reaches 10 per 20 sweeps, it will be profitable to apply an insecticide. This figure may be reached at any time between the middle and the end of November.

The larvae of the case-bearer are well protected within the florets or within their cases from low volume sprays and attempts at control have been directed against the moths themselves. A spray applied at the peak of the first brood moth flight should give the maximum kill which is possible for a single spray. If more than one spray is to be applied, the best timing can only be determined by periodic sampling of moth numbers. The succession of flowering clover heads reduces the effectiveness of residual insecticides and these also present hazards of residues in animal products though when applied to seed crops there is, in effect, a built-in withholding period of 8 weeks before harvest.

The relative toxicities of different insecticides, as evidenced by the immediate kill of moths present at the time of spraying, may be readily compared by pre- and post-treatment sampling of sprayed plots. When only the first brood is concerned in damage to the seed, there should be a direct correlation between percentage moth kill and increase in seed yield. This is likely to be obscured if the harvest is so late that the larger second brood contributes significantly to the seed damage. Small plot experiments have not given satisfactory results in demonstrating the effect of treatment on seed yields. Even large plots (1 acre) may be unproductive because of insufficient replication or the effect of the second brood.

It is essential that the insecticide used should have no adverse effects on honey-bees by immediate contact, residual action or accumulation in the nectar. DDT, toxaphene and trichlorfon (Dipterex) have been recognized as safe to use on flowering white clover crops, if applied in the early morning or the late evening when the bees are not actively working the crop. The first two of these have been extensively used by farmers. Some information on the performance of these insecticides in respect of the kill of moths and the reduction of seed losses is presented in Table 1.

TABLE 1: INSECTICIDES AND CASE-BEARER CONTROL

Insecticide & Dosage (lb/ac)	Date Applied (Single spray)	Moth Popula- tion on Control before Tr.	% Kill of Moths present	Harvest Date	Seed Yield, lb/ac.		
					Con- trol	Treat- ed	Signif. Incr.
Toxaphene 2	Jan. 11, 1962	100/20	86	—	—	—	—
DDT 2	Jan. 11, 1962	100/20	95	—	—	—	—
DDT 1	Nov. 28, 1962	10.7/20	98	Jan. 25, 1963	403	463	60*
DDT 2	Nov. 28, 1962	10.7/20	99	Jan. 25, 1963	403	496	93*
DDT 1	Nov. 28, 1963	12.0/20	96	Feb. 13 1964	358	380	—
Trichlorfon 1	Nov. 28, 1963	12.0/20	87	Feb. 13, 1964	358	358	—
Trichlorfon $\frac{1}{2}$	Nov. 28 1963	12.0/20	52	Feb. 13, 1964	358	333	—

* Difference between these not significant.

DDT is both the most effective and the cheapest. Its residual action on moths emerging after treatment was, however, both slight and of short duration. If the use of DDT and toxaphene is not permitted, because of the risk of accumulated residues in animals, any substitute is likely to be one of the organophosphorus insecticides. These, though they are less stable and have a shorter residual life, are not *ipso facto* harmless to bees.

Trichlorfon, which is accepted as harmless to bees, is slightly less toxic to the moths and slightly dearer than DDT. At the moment, and until others are proved superior, it would be the insecticide of choice as a replacement for DDT, even though there is no direct evidence of its effect in increasing seed yields.