CONTROL OF CLOVER CASE-BEARER MOTH

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Summary

DDT 1.0 lb and "Cidial" 1.25 lb per acre gave up to 98% kill and measurable reduction in clover case-bearer moth (*Coleophora alcyonipennella* and *C. spissicornis*) populations for up to 12 days after spraying. Trichlorphon 1.0 lb was significantly less effective. Worthwhile seed yield response can follow treatment of white clover (*Trifolium repens*) at the peak of flowering where the clover moth population is likely to exceed 30 per count of 20 sweeps. Two applications of insecticide at about 10 days interval are indicated.

INTRODUCTION

BECAUSE white clover (*Trifolium repens*) is a perennial, and high certification group seed which commands a high price is in short supply, many farmers attempt to grow more than one crop of seed. Experience has shown that seed yields are lower and less reliable in the second year. This is due to a number of factors, including over-crowding of clover runners, grassy weeds and the feeding of clover case-bearer (*Coleophora* spp.) caterpillars. This "clover moth" damage can be severe, leading sometimes to complete loss of crop.

Since Hoy (1961) showed that the percentage damage could be reduced by spraying massive doses of toxaphene during flowering, and Dumbleton (1964) demonstrated yield increases by spraying DDT, there has been increasingly widespread use of both these chemicals. The successful elimination of grass competition with paraquat (Leonard, 1964) has further increased the scope for insecticides.

The advent of the Agricultural Chemicals (Insecticides) Regulations 1961, restricting the use of chlorinated hydrocarbons, provided an impetus to test possible alternative chemicals in addition to the necessary work with rates and times of application. The large number of possible treatments makes it desirable to have plots as small as possible without incurring undue risk of treatment effects being masked by re-invasion from untreated areas or by re-distribution of the unequal plot populations created by the treatments. Long narrow plots are the most convenient for spraying and harvesting with field-scale equipment.

Trials with possible alternatives to DDT using plot sizes allowing two replicates of six and ten treatments in a medium sized field are reported here. All rates are expressed in terms of active ingredient per acre.

EXPERIMENTAL

The crops were all second year clover. At Southbridge the rotation had been grass for seed, clover, clover and at Halswell, wheat undersown with clover, clover, clover. The three fields had been sprayed in the spring with paraquat to reduce grass competition.

Trial I: Southbridge, 1963-4 season.

DDT 1 lb per acre as 20% emulsifiable concentrate; trichlorophon 1 lb as 80% water-soluble powder; endosulfan 0.88 lb as 35% emulsifiable concentrate; "Cidial", 0.94 lb and 0.47 lb as 50% emulsifiable concentrate. Treatments applied December 16, 1963.

Trial II: Southbridge, 1964-5 season.

DDT 1 lb, trichlorophon 1 lb, "Cidial" 1 1/4 lb. The three chemicals were applied at two different times of application ("E" on December 10, 1964, and "L" on December 23, 1964) and as a double treatment ("E" + "L").

Trial III: Halswell, 1964-5 season.

Treatments as for Trial II. Time "E" on December 2, 1964, and time "L" on December 9, 1964.

Plots were 46 ft wide (two spray boom widths) and from 4 to 6 chains long, depending on the available area. Suitable headlands were left and the plots mowed and headed with the help of chain or brush pickup attachments.

Materials were applied in 22 gal of water per acre with fan tips operating at 40 lb/sq. in. pressure.

Trials I and II and the first spraying of Trial III were done between 5 and 7.30 a.m. and the final spraying of Trial III between 7.30 p.m. and 11 p.m. The earliest bees were noted was 7.20 a.m.

Moth counts were made before and after spraying. The number of moths per 20 sweeps of a 10 in. diameter net was taken as the unit count n . The counts were transformed to $x = \sqrt{n + 0.5}$ for analysis. To facilitate broad comparisons, the results are presented as % of unsprayed and the Duncan's test letters derived from the analyses are appended to indicate similarities and differences.

RESULTS

Moth counts made during Trial I indicated that the plot size used, in particular the width, enabled treatment differences to be followed for 7 days and gave measurable yield differences. In Trial II and the first spraying of Trial III, moth numbers fell sharply on the unsprayed plots after treatment possibly indicating movement of moths from high density to low density areas. However, treatment differences persisted from 3 days in time "L" Trial II, to 12 days in times "E" Trial II and "L" Trial III.

The overriding effect of weather conditions on counts determined the counting dates and as a result, treatment dates. Moth counts fell almost to zero in windy north-easterly conditions and/or temperatures below mid-fifties Fahrenheit. In Trial III for example on November 28, 1964, 20 counts made in mild north-westerly conditions gave a mean of 12.9 moths per 20 sweeps whereas the next 4 counts following a sudden change to a strong cold southerly gave a mean of 4.7 moths per 20 sweeps. In cool northerly conditions on December 10 and 11, (Trial III) 20 counts gave a mean of 1.5 and 0.6 moths per 20 sweeps, respectively. Since the net was dragged through the crop at the lowest point of each sweep, moths must shelter well down in the crop in adverse weather.

The figures presented in the moth count tables show that DDT 1.0 lb followed by "Cidial" at 0.94 lb and 1.25 lb have been the most

efficient in killing moths. In individual determinations both gave a high proportion of zero counts one to three days after treatment. Trichlorophon in the five separate applications recorded was significantly less effective and in two of the cases gave no control. To check the suggestion that this was due to few moths flying in the dewy morning conditions the second spraying of Trial III was done in the evening. The trichlorophon was applied at dusk when sweeps showed that moth flights were of the order of counts recorded for December 22, 1964. As the one- and four-day post-spraying counts indicate, results were similar to the morning sprayed "L" treatment of Trial II. In Trial I endosulfan was intermediate in effectiveness between DDT and trichlorophon. Counts made in observational swathes sprayed at the sites of Trials II and III gave similar results to Trial I for endosulfan 0.88 lb while toxaphene at 3.5 lb resembled DDT 1.0 lb both in initial reduction of moth numbers and subsequent build-up.

Additional moth count data have some bearing on the question of when to spray. Counts at the Halswell site in December, 1963, gave 4 moths per 20 sweeps on the 5th and 11 on the 19th. This first year crop yielded over 500 lb per acre of dressed seed. Even so, caterpillar damaged heads were easy to find at harvest. In 1964 pre-spraying counts were 1.8 on November 5 (all *Coleophora alcyonipennella*), 6.4 on November 19 and 12.9 on November 28 (25% of *C. spissicornis*). Numbers on dates subsequent to those recorded on the table for Trial III were 40 on January 8 and 17.2 on January 12, 1965. At the latter date flowering had almost finished and the ratio of moths to flowers was high.

In the main yield table Trial I, DDT was better than treatments other than endosulfan and "Cidial" 0.94 lb with a probability better than 19 to 1 that the difference was due to the treatment.

In Trial II "Cidial" proved significantly better than DDT or trichlorophon with the double application of "Cidial" better than all treatments other than "Cidial" "L". Two successive applications, independent of the chemical used, were significantly better than either date singly.

In Trial III initial analysis showed DDT superior to "Cidial" and trichlorophon but after adjustment for a visual plot vigour score made at harvest the difference proved not significant. Failure of this trial through accident of plot layout was disappointing since the history was better known than for the other trials. Abnormally dry conditions from the time of shutting up until harvest resulted in uneven recovery from spring grazing and paraquat spraying.

The yield increases of the order of 100 lb per acre obtained in two trials in medium yielding crops makes chemical control attractive provided total treatment cost is at or below about £5 per acre. Yield response appears to be related to efficiency of moth kill though the poor response to DDT and marked superiority of "Cidial" in Trial II cannot be explained on this basis.

Since moths emerge over a long period of time (as shown above) and live for one to two weeks (Dumbleton, 1963), and because the clover crop flowers over a long period of time and does not have a fixed harvest date in relation to stage of development as do annual crops, choosing the best time to apply treatment is something of a gamble. Comparing Trials I and II it appears that one application can give a similar yield response to two. But according to Trial II, individual treatment times can differ significantly in response so that the extra cost of two applications can be regarded as an insurance of approaching the most favourable time with one of the treatments. The indications are, in fact, that the added cost would be offset by a small yield advantage from two treat-

ments. This amounted to about 25 lb or 25% of the total increase in Trial II.

It seems, then, that application of a reliable insecticide to reduce moth numbers to zero for a short period during peak flowering will give appreciable yield responses when numbers of moths are likely to exceed 30 per 20 sweeps during this period. Counts of 10 moths per 20 sweeps at the end of November to the first week of December seem a reliable criterion that a harmful level will be reached. Two applications at about a 10-day interval seem warranted with the likelihood of a further application being necessary if the flowering is protracted. All crops should be inspected since damage does occur in first year crops.

"Cidial", an organophosphorus insecticide, appears a suitable alternative to DDT for control of clover case-bearer moth. Further trials are necessary to confirm that it can be applied without harm to bees.

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YIELD OF DRESSED SEED (LB PER ACRE)

<i>Treatment (lb)</i>	<i>Trial I</i>	<i>Trial II</i>	<i>Trial III</i>
	<i>Southbridge</i> 1963-4	<i>Southbridge</i> 1964-5	<i>Halswell</i> 1964-5
Untreated	252 b	194 dC	193
DDT 1.0:			
E	348 a	227 bcdABC	205
E+L	—	245 bcABC	203
L	—	191 d	294
"Cidial" 1.25*:			
E	282 ab	249 bcABC	152
E+L	—	304 aA	201
L	—	270 abAB	196
"Cidial" 0.47 E	252 b	—	—
Trichlorphon 1.0:			
E	231 b	212 cdBC	183
E+L	—	220 cdBC	134
L	—	190 dC	145
Endosulfan 0.88 E	319 ab	—	—
C.V.	10%	8.0%	10%

* In Trial I, "Cidial" was used at 0.94 lb.

TRIAL I: MOTH COUNTS RELATIVE TO UNSPRAYED=100

<i>Treatment (lb)</i>	<i>Date of Counting (1963)</i>	
	<i>Dec. 9</i>	<i>Dec. 13</i>
Unsprayed	100 D	100 dC
DDT 1.0	1 A	43 abAB
"Cidial" 0.94	4 A	35 aA
"Cidial" 0.47	26 B	69 cB
Endosulfan 0.88	30 B	54 bcAB
Trichlorphon 1.0	80 C	49 abA
C.V.	16%	11%
Unsprayed (actual count*)	72.0	26.6

* Moths per 20 sweeps. Means of 5 samples per plot. Pre-spraying moth count on December 5, 1963, was 24.4.

TRIAL II: MOTH COUNTS RELATIVE TO UNSPRAYED=100

Treatment (lb)	Date of Counting (1964)				
	Dec. 13	Dec. 17	Dec. 22	Dec. 24	Dec. 27
Unsprayed	100 B	100 b	100 b	100 c	100 cC
DDT 1.0:					
E*	20 A	24 a	23 a	48 b	62 bBC
E+L				8 a	26 abAB
L				3 a	24 aAB
"Cidial" 1.25:					
E	18 A	36 a	44 a	39 b	44 bABC
E+L				2 a	8 aA
L				3 a	21 aAB
Trichlorphon 1.0:					
E	104 B	172 bc	119 b	55 bc	54 bBC
E+L				23 ab	57 bBC
L				31 b	84 cC
C.V.	24%	26%	22%	34%	20%
Unsprayed (actual count†)	16.3	12.9	30.4	29.7	25.2
					39.3

* "E" sprayed December 2, 1964. "L" sprayed December 9, 1964.

† Moths per 20 sweeps. Means of two counts per plot. Pre-treatment count December 9, 1964=24.5.

TRIAL III: MOTH COUNTS RELATIVE TO UNSPRAYED=100

Treatment (lb)	Date of Counting (1964)					
	Dec. 4	Dec. 8	Dec. 9	Dec. 12	Dec. 21	Dec. 30
Unsprayed	100 B	100 C	100 D	100 D	100 CD	100
DDT 1.0:						
E*	54 A	31 A	52 C	42 BC	86 CD	111
E+L			5 aA	6 A	32 A	73
L			5 aA	3 A	47 AB	96
"Cidial" 1.25:						
E	52 A	41 B	11 bA	22 AB	64 ABC	143
E+L			5 aA	4 A	47 AB	96
L			3 aA	2 A	45 AB	137
Trichlorophon 1.0:						
E	104 B	118 D	51 C	66 C	118 CD	117
E+L			37 B	48 C	82 CD	149
L			32 B	60 C	117 CD	95
C.V.	22%	15%	33%	27%	22%	16%
Unsprayed (actual count†)	7.4	56.1	18.5	49.8	78.3	27.9

* "E" sprayed December 10, 1964. "L" sprayed December 23, 1964.

† Moths per 20 sweeps. Two counts per plot. Pre-treatment count November 30, 1964=21.1.