THE SUSCEPTIBILITY OF ADULT GRASS-GRUB TO INSECTICIDES

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Summary

Topical applications of insecticides in acetone solution to adults and larvae of the common grass-grub *Costelytra zealandica* shows that DDT, trichlorphon and U.C. 10854 are significantly more toxic to adults than larvae by this method and that adult males are significantly more susceptible than females to DDT and U.C. 10854. In a trial simulating spray treatments to pasture, azinphos methyl, diazinon, fenthion, trichlorphon, carbaryl and U.C. 10854, all at 2 lb and 1 lb per acre rates, all gave substantial mortality of adult males of a DDT-tolerant strain but effects on females were more variable. DDT at 2 lb per acre was virtually ineffective. The control of grass-grub by killing adults with transient chemicals is discussed.

INTRODUCTION

DAMAGE caused by the common grass-grub (*Costelytra zealandica*) has been successfully controlled over wide areas of New Zealand by the use of ppi-DDT at the rate of 2 lb per acre applied in the main with superphosphate. The introduction of regulations governing the proportion of a farm which may be treated in any one year and requiring only granular formulations to be used is not expected to interfere with control of damage in paddocks where DDT tolerance has not become apparent or where soil factors appear not to influence the effect of the insecticide.

Where failure occurs owing to one or other of these two factors, the total area where control is limited by soil conditions is static; the number of sites where control is limited by the development of strains of *C. zealandica* tolerant to DDT will not be static and a deterioration in the control given by DDT can be expected over a period of time.

Apart from any consideration of the advantages arising from the use of a chemical which cannot leave undesirable residues, these two factors necessitate an alternative method of control. Some possibilities have been considered by Fenemore (1964) and of these the present paper gives data relating to the susceptibility of adult beetles to some insecticides.

EXPERIMENTAL

LARVAE

Data cited here supporting the reasons given for control failure have been gained by laboratory experiments allowing the construction of dose-response curves. DDT has been applied topically in acetone solutions to batches of field-collected insects by means of a microloop delivering 0.358 microlitres and effects have been assessed by the ability of insects to display co-ordinated movement

by burrowing beneath moist soil three days after treatment. Since not all affected larvae are dead after this period, critical amounts of insecticide are expressed as the effective concentrations needed to affect half the sample (E.C. 50). Toxicological data have been calculated by the method of Litchfield and Wilcoxon (1949).

TABLE 1: RESPONSE OF THIRD INSTAR LARVAE OF *COSTELYTRA ZEALANDICA* OF DIFFERENT POPULATIONS IN 1964 TO DDT APPLIED TOPICALLY IN ACETONE TO BATCHES OF 50

	Percentage Affected at Stated Dose Level		
	Riwaka May	*Te Kuiti* April*	*Baton Valley May*
1 lb DDT applied per acre	8	10	0
Earliest known year of application	1954–55	1961	—
Concentration of DDT (mg per ml):			
200.0†	66	—	—
100.0	28	—	—
60.0	23	—	—
40.0	13	—	—
20.0	8	—	90
10.0	2	90	81
6.0	—	65	70
4.0	—	45	62
2.0	—	30	35
1.0	—	20	27
0.6	—	—	27
0.4	—	—	17
0.2	—	—	10
E.C. 50	148.0	3.5	2.5
95% confidence limits of E.C. 50	120.3–182.0	2.5–4.8	2.0–3.125

* Batches of 20 larvae.
† Administered as two separate doses of concentration 100.0.

Table 1 gives results of tests on samples of three populations. That at Riwaka is DDT-tolerant and the other two DDT-susceptible. The population at Baton Valley has never been treated with any insecticide. That at Te Kuiti has been treated with DDT in four successive years. Under such a treatment regime, the continued thriving of grubs which show a typical susceptible response under laboratory conditions indicates failure of the insecticide to contact the insects.

ADULTS

Similar experiments have been conducted on adult beetles. The test insects were collected as mating pairs from a hedgerow and therefore probably constitute a very mixed sample in terms of age and physiological status, particularly in regard to females. The insecticide solution was applied to the coxal region of each beetle and results assessed after three days during which the test insects were held in moist sawdust and provided with peach foliage as

food. In the adult stage there is a clear distinction between dead insects and survivors, but for convenience assessments were made by counting as survivors those which burrowed in sawdust.

Table 2 gives the results of experiments with a chlorinated hydrocarbon, an organophosphorus and a carbamate insecticide against larvae and adults. In each case adults are significantly more susceptible than larvae by the treatment method used, and adult males tend to be or are more susceptible than adult females.

TABLE 2: SUSCEPTIBILITY OF LARVAE AND ADULTS OF THE PRETTYBRIDGE (DDT-SUSCEPTIBLE) STRAIN OF *COSTELYTRA ZEALANDICA* TO THREE INSECTICIDES APPLIED TOPICALLY IN ACETONE SOLUTION TO BATCHES OF 40 LARVAE AND 30 ADULTS

Insecticide	*DDT*			*Trichlorphon*			*U.C. 10854**		
	Larvae	*Adults*		*Larvae*	*Adults*		*Larvae*	*Adults*	
		M.	*F.*		*M.*	*F.*		*M.*	*F.*
Lower confidence limit	1.09	0.11	0.25	0.71	0.14	0.24	0.86	0.07	0.15
E.C. 50†	1.39	0.13	0.32	0.96	0.19	0.29	1.14	0.095	0.19
Upper confidence limit	1.77	0.17	0.40	1.30	0.25	0.34	1.50	0.13	0.24
E.C. 90†	4.50	0.30	0.68	3.38	0.35	0.51	5.50	0.38	0.46

* Experimental carbamate of Union Carbide Chemicals Co. 3-isopropylphenyl N-methyl carbamate.
† In micrograms per microlitre.

TABLE 3: MORTALITY IN BATCHES OF 50 WILD CAUGHT BEETLES OF A DDT-TOLERANT POPULATION OF *COSTELYTRA ZEALANDICA* CONFINED TO SPRAYED PASTURE DISCS

Material (*lb a.i. per acre*)	*Percentage dead*			
	2 days after enclosure		*8 days after enclosure*	
	M.	*F.*	*M.*	*F.*
SERIES 1				
Azinphos methyl 2	76	8	Not assessed owing to high control mortality	
Azinphos methyl 1	80	42		
Diazinon 2	96	26		
Diazinon 1	70	18		
Trichlorphon 2	100	74		
Trichlorphon 1	98	66		
DDT 2	18	8		
Control	4	0	92	50
SERIES 2				
Control	3	0	24	26
Fenthion 2	62	28	96	92
Fenthion 1	38	24	96	88
Carbaryl 2	54	40	94	78
Carbaryl 1	60	34	98	86
U.C. 10854 2	50	24	92	72
U.C. 10854 1	44	14	94	86

Pot Experiment with Adult Beetles

In 1963, a small-scale experiment simulated the effect of treatment of pasture to adults. Materials were applied as sprays at the rate of 40 gal per acre to 2 × 1 yd plots of mown pasture using an Oxford Precision Sprayer. When sprays had dried, discs 5 in. in diameter and 2 in. deep were taken from the centre yard of these plots and laid on perforated zinc discs at the bottom of open-ended cans resting on damp sawdust. Test insects had been collected by sweeping from a hedgerow bounding a heavily infested field. Before use they were held in damp sawdust and supplied with peach foliage as food. On the day of treatment, 50 beetles of each sex were exposed to each treatment.

Treatments listed in Series 1 in Table 3 were set up on November 25, 1963, and those in Series 2 one day later. Rain which wetted the top 3 in. of the ground fell between the establishment of the two series and the unsuitable state of dryer soil is reflected in the high mortality of controls in Series 1 which prevented a second assessment of effect being made. Assessments were made two and eight days after establishment.

At two days, only dead beetles on the surface were recorded. At eight days, the entire disc was dissected and all live and dead beetles recorded.

DISCUSSION

The data in Table 3 have not been subjected to statistical analysis, thus comparisons between materials cannot properly be made; nevertheless, a degree of effect is evident for all materials tested, with the possible exception of DDT, and a high degree of effect is evident for some. Data presented in Table 2 suggested greater susceptibility of males to the three groups of insecticides represented there, but the higher mortality of males achieved in the pot trial may be a reflection of greater activity and hence exposure rather than simply greater susceptibility. The relative vulnerability of the sexes to toxicants applied to pasture is of some significance since a high mortality of only one sex, either of males before mating or of females before oviposition, would substantially reduce the numbers of larval progeny. However, unless annual treatments are to be considered, reductions of larval progeny much below 100% obtained with a transient chemical are not likely to be useful in practice since quite low populations of larvae can cause significant damage to pasture and succeeding generations would be unchecked by any chemical residue.

Kelsey (1951) has recorded that males usually emerged earlier in the season and each night than females, thus females are usually mated as soon as they appear and seldom fly. He also records that the first batch of eggs is not laid until seven days after mating.

Also of importance in connection with the possibility of control by attacking the adult is the frequency with which individuals of either sex emerge and feed, since this could have a bearing on the timing of treatments.

The design of control measures against adults would be aided by a better understanding of the habits of the beetles and acquisition of such knowledge for a univoltine species in which the immature stages predominate in time is not likely to be rapid. In spite of this, the use of non-residual insecticides against adults in field trials

coupled with simultaneous observations on adult abundance and behaviour would be useful. It should explore the feasibility of securing grass-grub control through adult control and provide data in terms of times of application and rates and formulations of materials under different herbage conditions. Carefully designed experiments of this nature could also yield information on movement and reinfestation by adults, and the effect of competition among larvae at different population densities under similar edaphic conditions, thus acting as chemical tools for the provision of biological data.

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