THE DISTRIBUTION AND FREQUENCY OF DDT - RESISTANCE IN GRASS GRUB

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Summary

Resistance to DDT in the grass grub *Costelytra zealandica* (White) occurs in both the North and South Islands. In 1967, 108 pastures sampled for larvae on a 2½ mile square grid basis in Ashburton county showed that, while over 40% of the fields were themselves uninfested, infestations occurred round the margins of many of these and, of the remaining 60 fields, 24 or 40% supported DDT-resistant strains of grass grub. Case histories of DDT use are too scanty to relate usage and selection of resistant strains for prediction of what future failure rate may be expected.

INTRODUCTION

METHODS for determining the susceptibility of the grass grub to insecticides were established in 1961 and lowered susceptibility to DDT was first discerned in 1962 (Elliott and Perrott, 1965).

Since then the susceptibility to DDT of samples of third instar larvae from sites in most of the major farming areas has been evaluated and, although not all failures are attributable to this cause, resistance to DDT is now known to occur in many parts of the country.

Until 1967, no systematic survey of this aspect of grass grub biology had been conducted and knowledge of DDT resistance had come from areas where application of DDT to existing infestations had failed to give control. Recognition of the presence of resistance has therefore depended on populations reaching damaging levels for their existence to be noticed. The recognition of resistant strains in any locality seems therefore to be partly an indication of seasonal abundance and gives no real indication of the threat to grass grub control posed by this phenomenon.

This paper describes the results of the first of a proposed three seasons' sampling intended to provide information, in relation to DDT usage, on the distribution of grass grub infestation, the incidence of resistant strains in a defined area, and, by continued sampling, indications of what changes are occurring.

METHODS

The designated area was that part of Ashburton County bounded by the Ashburton and Rakaia rivers, the sea, and the foothills of the Southern Alps and was chosen for its broad uniformity in terms of soil type, farming pattern, and vulnerability to grass grub damage.

The area has the further qualification of a long history of DDT usage.

Sample points were based on a 2½ mile square grid pattern, fields at the gridline intersections being sampled for larvae provided that they had been in pasture for not less than three years. If the field at this point did not meet this requirement, the nearest suitable pasture was chosen. Where the designated field yielded no larvae, adjacent areas (fencelines, lanes or neighbouring fields) were sampled and these results recorded separately.

Designated fields were inspected visually for grass grub damage and if damage was apparent the sample of larvae was taken from the most ravaged spots. The 180 larvae from any one field were collected from discreet 7 in. spade squares spaced in a circuit around the field and the number in each of the first 10 squares recorded. In some instances, fewer than 10 squares were needed and since the sampling was not truly random the data on larval density in Table 1 do not have a common basis and tend to represent the extreme situation rather than the field as a whole.

All samples were of third instar larvae collected between May 6 and August 14, 1967.

TABLE 1: ABUNDANCE OF LARVAE IN SURVEY FIELDS

<i>Larval Density/sq. ft</i>	<i>No of Fields</i>	<i>as %</i>
nil	48	44.4
<20	9	8.3
21 - 40	17	15.7
41 - 60	20	18.5
61 - 80	4	3.7
81 - 100	4	3.7
>100	1	0.9
no data	5	4.6

In estimating susceptibility to DDT, batches of 25 unsexed larvae were treated topically with acetone solutions of DDT by means of a microloop delivering 0.36 µl and effects on the insects were measured by their capability of burrowing in soft moist earth three days after treatment (Method II of Perrott and Elliott, 1965). Complete regression lines were not constructed for each sample, but, because susceptibility can only be defined within rather broad limits, the approximate discriminating dose (Perrott, 1965) and those in the usual dose range (see Fig. 1) lying on either side of it were used to indicate the slope.

DISCUSSION AND RESULTS

Seasonal changes in susceptibility to DDT occur in strains of grass where no selection pressure by DDT has been applied (Elliott and Perrott, 1965). Changes also occur in strains where selection is operating but, because DDT in the soil is a slowly acting insecticide, these are probably due to the progressive culling of the susceptible fraction of the population. Thus, a wide variety of results accrues from the exposure of samples of field populations to standard doses of DDT in the laboratory.

In most cases, interpretation of results is simple, but in a few instances it is not clear whether the response displayed by a sample represents the

Fig. 1

extreme of "normal" susceptibility or does indeed indicate the presence of a small proportion of resistant material. For these reasons, it is convenient to group results in these three classes: Susceptible; resistant (whether or not selection seems to have proceeded to the point where resistant material only survives); and a small intermediate group comprising those whose status is not yet clear but for which clarification should come from the results of continued sampling in a succeeding generation.

Since for practical purposes interest lies in the amenability to control of field populations by the permitted rate of 2 lb DDT/acre, it is noted here that, in experiments extending over two larval generations in the field (D. C. F. Perrott, unpublished data), the strain giving the regression line marked A in Fig. 1 was virtually eradicated by DDT at 2 lb/acre whereas that marked B was not significantly produced by 16 lb/acre. nor eradicated by four times that amount. These observations have been used in the interpretation of results.

Not all sampling points yielded larvae; this distinction and the categories of susceptibility of samples from those which did are presented in Table 2. However, for 30 of the 48 uninfested fields, larvae were collected either from fencelines or adjoining grassy areas such as lanes and, of these, 9, 4, and 17 samples fell into the resistant, intermediate and susceptible categories, respectively. If infestations arise from invasion instead of (or as

TABLE 2: PRESENCE OF LARVAE IN SURVEY FIELDS AND THE SUSCEPTIBILITY OF SAMPLES OF THIRD INSTAR LARVAE TO DDT

	<i>Absent</i>	<i>Present</i>		
	48	60		
		<i>Susceptible</i>	<i>Intermediate*</i>	<i>Resistant</i>
	48	33	3	24
as %	44.4	30.5	2.8	22.2

* See text.

TABLE 3: SUMMARY OF AVAILABLE HISTORY OF DDT USAGE OVER SURVEY FIELDS

<i>lb/acre</i>	<i>Amount Used</i>	<i>No.</i>	<i>Time of First Use</i>	<i>No.</i>
			<i>Period</i>	
none		14	before 1950	1
some		1	1950 - 54	3
2		20	1955 - 59	11
4		18	1960 - 64	22
6		8	after 1964	12
8		2		
10		0		
12		1		

well as) by increase of existing low numbers, then about 30% of the uninfested sample fields are threatened by strains which would not be amenable to control by DDT. On the assumption that the survey sites are a fair sample, then it is likely that some fields supporting susceptible strains also abut areas with resistant populations, so that in a pessimistic view some 50% of the grassland in the survey area either supports resistant strains or is at risk.

It had been hoped that some relationship might emerge between presence of resistance strains and treatment history. Table 3 presents a summary of the information obtained (from owners) of the survey fields. This summary does not tally with the known general DDT topdressing practice in the area over the last two decades and serves only to show paucity of records or shortness of memory. In addition to this and the uncertainty of the full significance of movement by adult females, such facts as the discovery of resistant strains in untreated fields and a susceptible strain in the one survey field known to have been treated before 1950 emphasize the difficulty, if not impossibility, of devising any formula expressing the number of years of successful DDT use reasonably to be expected before failure due to resistance occurs.

REFERENCES

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