THE TOXICITY OF INSECTICIDES TO GRASS-GRUB LARVAE

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Summary

A method is described for examining the toxicity of insecticides to grass-grub (*Costelytra zealandica* Wh.) larvae, by thoroughly mixing the insecticide with soil and retaining larvae in the treated soil in pots. By selecting a series of dosages, dosage mortality curves and LC_{50} s can be calculated. Results are presented from tests with DDT, lindane, heptachlor, diazinon, endosulfan, azinphos-methyl, "Telodrin", UC.10854 (experimental carbamate) and UC.16888 (experimental organo-phosphate) against 3rd instar larvae, and with DDT, heptachlor and diazinon against 1st instar larvae. The significance of the results obtained is discussed in relation to practical control measures.

THIS PAPER is in the nature of a progress report on a project, commenced early in 1962, to investigate the toxicity of a wide range of insecticides to grass grub (*Costelytra zealandica* Wh.) larvae.

The criticism can be made of laboratory test procedures for insecticides that they do not duplicate field conditions. The very essence of any laboratory test method is standardization of many of the variable factors met with under practical conditions. This makes for reproducibility of results, but means that factors governing the effectiveness of an insecticide in the field may be overlooked.

There are, however, strong reasons for undertaking studies under artificial conditions. First, the large number of candidate insecticides now available makes adequate testing of them all in the field, at various rates and in differing formulations, a practical impossibility. Secondly, the very patchy nature of grass grub infestations makes accurate field comparison between treatments almost impossible. This variation in population levels of grass-grub can of course be completely eliminated under artificial conditions. Finally, the effectiveness of an insecticide treatment against a pasture inhabiting insect depends very much on whether the toxicant penetrates the soil adequately. This can be affected by formulation, rainfall and soil type. In the test method described the insecticide is mixed intimately with soil to eliminate variation in penetration from materials applied to the surface. Results from tests of the type described should be used as a guide to planning field trials, together with other available data on the toxicants concerned. Thorough testing under a variety of field conditions is still essential before any recommendation can be made for practical use.

TEST METHOD

The larvae of grass-grubs pass through three growth stages or instars during their development. The third larval instar is the most convenient stage to work with, for several reasons. First, it is present in the soil, and available for test purposes, for five or six months of the year, from about April to September. Secondly, any treatment lethal to the third instar will almost certainly be effective

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against the younger, smaller stages and, finally, under practical conditions pasture is generally treated in the autumn when grass-grub is present as the third larval instar.

Details of the test method employed are as follows.

The correct quantity of insecticide, in the form of a 1% dust, to treat a certain volume of soil, is added to a small amount of dust-fine soil (sieved 40 mesh). After stirring and rolling for five minutes, this is then added to the bulk of soil to be treated, and then mixed in a tumbler mixer for a further ten minutes.

The treated soil is then placed in 5 in. plastic pots, slivers of carrot inserted as food, and ten larvae introduced into each pot.

The pots are housed under cover, but without artificial heat, for one month, and watered regularly to maintain the soil just moist. Temperature in the pots is recorded twice daily.

After four weeks grubs are extracted and assessed. The criterion of toxic effect used is "ability to walk". Larvae for test work are dug in the field from an area which has no history of insecticide treatment. After holding at 50 to 55°F for 3 to 4 days, larvae of healthy appearance only are used for tests.

Five dosage levels of each insecticide have generally been used, with 50 larvae at each dosage level. Survival in untreated controls has been 80 to 90% over the four-week test period.

RESULTS

Results of three tests against 3rd instar larvae are given in Fig. 1. Dosages of insecticide are expressed as lb of active ingredient per 3 in. acre, and for each toxicant, log dosage is plotted against percentage mortality on a probit scale. Graphs are plotted and LC_{50} (concentration required to affect 50% of larvae exposed) 95% confidence limits calculated according to the method of Litchfield and Wilcoxon (1949).

As only a few materials can be tested at any one time, DDT has been included each time as a standard of comparison. This has proved a difficult material to work with, as it is apparently very slow acting against 3rd instar larvae and has given anomalously low mortalities. The mortality end point also is not at all clear cut, and dosage/mortality regression lines have generally been less satisfactory than with the other insecticides examined.

The poor regression lines, and consequent wide confidence limits of LC_{50} estimations for DDT, are apparent from the figures. Nevertheless, all other materials can clearly be separated in acute toxicity from DDT with the exception of azinphos-methyl.

The results of a single test conducted with 1st instar larvae are given in Fig. 2.

The toxicity of diazinon and heptachlor is essentially the same in this case as for 3rd instar, but DDT appears to be relatively more toxic to 1st instar than to 3rd instar. On the results obtained, no distinction can be made between the toxicity of DDT, heptachlor and diazinon against 1st instar larvae.

DISCUSSION

The results obtained with DDT in the tests reported appear anomalous in view of the known effectiveness in practice of ppi-DDT at 2 lb per acre. The explanation probably lies in the extremely persistent nature of DDT, and its action against stages of grass-grub other than 3rd instar larvae. The results obtained with field collected 1st instar larvae, indicate that they are more readily killed by DDT than the 3rd instar stage. Larvae freshly hatched from eggs would probably be very susceptible. It is also conceivable that DDT acts against emerging adult beetles.

Fig. 1: Results of three tests against third instar larvae of *Costelytra zealandica* Wh. for a four-week test period.
Mean soil temperature: 50 to 55°F.

This experience with DDT suggests that any insecticide which is known to be highly persistent in soil would be worth testing in the field, even though it does not show up as highly toxic to 3rd instar, in the type of test described.

Although results are available from a few tests only so far, the high toxicity of some insecticides outside the chlorinated hydrocarbon group to grass-grub larvae has been demonstrated.

Fig. 2: Results of a test against first instar larvae of *Costelytra zealandica* Wh. for a four-week test period. Mean soil temperature: 50 to 55° F.

This does not necessarily mean that these materials will be effective in the field, as they must then prove stable enough to be applied to the pasture surface and be washed into the soil by rain. Results are sufficiently encouraging, however, to warrant field trials with some organo-phosphates.

From the residue point of view, the significance of being able to utilize organo-phosphate insecticides for grass grub control needs no elaboration.

REFERENCE

Litchfield, J. T., and Wilcoxon, F. (1949). *J. Pharmacol. & Exp. Therapeutics*: 96 (2).