BIOLOGY AND CONTROL OF STEM WEEVIL

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Summary

In a spray experiment, a number of organophosphate insecticides at 8 oz active ingredient per acre failed to control the stem weevil (*Hyperodes bonariensis* Kusch.) at the adult stage. In a second experiment using compounds in prill, granule and powder form, only "Telodrin" showed promise as a controlling agent. The theoretical effectiveness of a range of insecticides against adults is assessed from the results of some topical toxicity tests.

INTRODUCTION

SINCE Morrison in 1935 reported that the stem weevil, *Hyperodes bonariensis* Kusch., had become a pest in wheat, there has been nothing published in the literature to indicate that an effective method of field control has been developed. Kelsey (1958) found in laboratory tests that DDT and lindane would control the adults, while Pottinger (1961) suggested that these compounds applied as a dust in superphosphate at the rate of 2½ lb (rates given in lb active ingredient per acre) might prove effective. May (1961) expressed the view that egg or larval parasites would appear to offer the best hope for control.

There seems to be no immediate prospect of achieving biological control, so that field trials at the Ruakura Agricultural Research Centre, Hamilton, have been confined to evaluating methods of chemical control. Two trials will be discussed briefly, and in a following section will be given the results of some topical tests and their relation to the results of the trials.

TRIAL I

METHOD

This was a spray trial, mainly with organophosphates, the object being to kill the early larvae and overwintering adults as well. Owing to the time of application, namely the end of July, 1963, no really effective control of the first generation larvae could be anticipated. Since, however, the most vulnerable part of the life-cycle appears to be the adult phase, it seemed worth while to determine the effects of the toxicants used upon the adult weevils instead. The organophosphate compounds used were vamidothion, dimethoate, demeton-O-methyl, thiometon and ethion, all in emulsifiable solution or concentrate form; additional materials were menazon wettable powder plus wetting agent and DDT emulsion.

All were used at the rate of 8 oz and were diluted and applied at the rate of 30 gal per acre with a tractor boom (nozzles No. 32M). There were three replications per treatment, the plots being 34 ft long by 8 ft wide.

SAMPLING TECHNIQUE

Since the object was to assess the kill of adults, this was done by flooding turfs dug from each plot. In brief, the method employed was to dig the turfs to a depth of two or three inches, trim the grass to about an inch in height and deposit the turfs in plastic basins containing water at a temperature of 35 to 37°C (to increase activity). The water covered the turfs to about an inch above the top of the grass. Any debris present was removed and heated gently on paper over a hot-plate to drive out any adults hiding there. This is especially important when sampling high populations. Any found in this way were added to those recovered from the basins.

That the method is effective is shown by the following. Forty live adults and two dead ones were placed on the upper surface of a cut turf which had previously been shown to be free of them. The turf was exposed to sunlight so as to drive the insects to the shelter of the grass crowns; all were recovered by the flotation treatment in two hours and again 18 hours later after storage overnight. It is noteworthy that dead adults may be recovered in this way but that no pupae have ever appeared by this method.

RESULTS

As with many soil animals, stem weevil is given to aggregation. This results in much variation within the field population of a given area. In the present case, numbers ranged from 0 to 8 per square foot, with a mean for the whole trial of 3 per square foot. No treatment showed any significant difference from control. At the rate used, therefore, these compounds show no promise against adult stem weevil.

TRIAL II

METHOD

In this second trial, attention was given to a small range of solid insecticides, some of which are known to possess high residual action. The materials were applied in full on two separate occasions; the first application was made on September 9, 1963, with agricultural lime as a diluent. No effects could be determined subsequently since the weevil population density was too low, being under 0.1 per square foot in October and 2.5 per square foot towards mid-November. At this time the pasture had grown beyond the capacity of sheep to graze it and it was cut by forage harvester, the crop being removed after cutting.

Subsequent examination showed a complete absence of stem weevil adults and it was assumed that the beating and suction action of the harvester had removed them. Later investigations elsewhere disproved this, as in the second instance no depopulation could be recorded. It must be assumed, therefore, that in the first case the disturbance coupled with other conditions precipitated a dispersal flight.

The second application of insecticide took place on January 14, 1964, using sand as a diluent on this occasion. Hand-spreading was employed on this date, whereas a mechanical spreader was used with the first application. Plot sizes were 1/80 acre and there were 3 replicates. The toxicants, their formulations, rates of application, and results of four examinations are given in Table 1. The mean adult numbers given are means of nine half-square-foot samples in the first two instances and twelve in the second two (*i.e.*, three and four samples per replicate respectively).

TABLE 1: THE EFFECT OF SOME INSECTICIDES UPON ADULT STEM WEEVILS

Insecticide (lb)	Mean No. Adult Stem Weevils per Sample			
	No. Weeks 3	after 7	2nd 12	Application 18
DDT prills 1.0	2.4	17.0	7.7	14.7
DDT prills 2.0	3.7	26.6	9.3	10.3
DDT powder 1.0	3.6	35.2	8.1	15.3
DDT powder 2.0	5.1	19.8	11.8	19.4
1-Bromo-chlordene granules 2.0	2.9	13.3	5.9	12.5
1-Bromo-chlordene granules 4.0	3.3	14.6	6.4	16.2
Heptachlor granules 2.0	2.2	6.6	5.7	8.3
"Telodrin" granules 0.5	0.3	1.2	0.7	5.6
Diazinon granules 1.0	2.2	14.2	8.8	22.9
Control	1.7	16.9	8.6	8.8

The results given in Table 1 have not been subjected to statistical analysis, but it seems clear that "Telodrin" exerted an early control extending to some period between the 12th and 18th weeks, by which latter date the effect was falling off. Heptachlor alone of the remaining compounds seems worthy of further investigation. The remainder show no evidence of control at any stage.

The toxicants used were directed at the adult weevils and would be expected to act as contact poisons. Although relatively mobile (painted adults have been observed to move 4 ft in 19 days from liberation at Ruakura), the chances of so small an insect making contact with a granular insecticide are small. This excludes the possibility of granule dispersion by rain or other agency. Table 2 gives an analysis of particle distribution of some of the compounds used; this assumes, of course, a regular degree of scattering.

TABLE 2: ESTIMATED NUMBER OF PARTICLES OF SOME INSECTICIDES PER SQUARE FOOT

Insecticide (lb)	Weight Assessed (g)	No. Particles Counted	Mean No.	No. Particles per sq. ft
DDT prills 1.0	2.0	916,976	946	40
DDT prills 2.0	—	—	—	80
1-Bromo-chlordene 2.0	0.05	534,474	504	2,130
1-Bromo-chlordene 4.0	—	—	—	4,260
Heptachlor 2.0	0.25	948,969	959	810
"Telodrin" 0.5	1.0	471,538,571,563	536	113
Diazinon 1.0	0.10	529,627	578	1,220

With DDT powder no assessment of particle distribution was possible; its failure as a prill formulation might be expected, but lack of control as a powder, even at the 2 lb rate, is a striking feature of the trial.

INSECTICIDE SCREENING TESTS FOR STEM WEEVIL

The effectiveness of a range of materials against the adult stem weevil has been assessed. The method used was one of many possible techniques customarily employed in toxicant screening tests, having regard to the small size of the insect, the nocturnal feeding activity, much of which occurs above ground level, and the ground-dwelling habit during the day, it seemed that a contact method would offer the best possibilities.

THE METHOD

The insects were dropped into the test fluid in a small flask and shaken gently for 60 seconds; they were then filtered off on nylon gauze and gently transferred from this with a pair of fine forceps to a piece of Whatman's No. 1 filter paper. They were finally shaken into a small glass vial of 10 ml capacity, after which the vial was sealed with a tightly-fitting plastic top.

Ten adults were employed per dilution. Test vials were maintained in darkness at 28°C and examined at the 18th hour; if at that time the mortality indicated that the range of dilutions was unsatisfactory, a further test range was set up. Final results were read at the 24th hour. Deaths only were recorded, as it has been found that individuals apparently moribund at the 18th hour may recover by the 24th. The dead individuals are readily differentiated from those "playing possum" by the position of the legs, which tend to be folded across the body.

Owing to the large numbers of insects required, the necessary repetition of many tests, and the range of materials tested, it was not possible to assess kills at the true LC50 level. However, from the results obtained from the five or more dilutions employed in each case, it has been found possible to group insecticides within a range of multiples of ten or more expressed as a rough 50% kill within the range given. The concentrations are micrograms per millilitre. Table 3 summarizes the results.

TABLE 3: RELATIVE TOXICITY OF SOME COMPOUNDS AGAINST STEM WEEVIL IN THE TEST DESCRIBED. LC50's PROBABLY FALL WITHIN THE RANGE SHOWN

<i>Range of Concentration (mg/ml)</i>	<i>Insecticides (Listed alphabetically in each Group)</i>
Below 10	diazinon, "Imidan", lindane, "Telodrin", "Zectran"*
10-50	demeton-O-methyl, dieldrin, melathion, phorate
50-100	DDT, dichlorvos
100-200	carbaryl, thiometon
200-500	carbophenothion, dimethoate, trichlorphon
500-1,000	—
1,000-10,000	aldrin, heptachlor
10,000 and over	chlordane, menazon, vamidothion, "VC-13"

* Now withdrawn.

DISCUSSION

Autumn dispersal flights by adult weevils are said to be common in Canterbury (Kelsey, 1958; Pottinger, 1961), so that rapid reinfestation of a trial is likely. The small plot technique seems feasible in

the south Auckland area as there is less evidence for flight movements there. Possibly the trial site at Ruakura Agricultural Research Centre would not now be liable to reinfestation, since a survey has revealed no stem weevil infestations in adjacent farms.

It should be mentioned that trial results were evaluated by adult counts and not by assessment of pasture damage since no damage was evident on the trial during the 1963-64 season, although the stem weevil population was high. Presumably weather conditions favoured rapid plant recovery.

Comparison of trial results with the series of compounds arranged in order of diminishing stem weevil toxicity shows that "Telodrin", the most successful insecticide in the field test, is also included in the most toxic group of compounds. Diazinon in the same group showed little promise in the field; no explanation for this can be offered other than the possibility that early breakdown occurred. It is also difficult to account for the failure of demeton-O-methyl, the most toxic of the materials used in the spray trial; possibly a rate of 8 oz per acre is insufficient.

Finally, although "Telodrin" offers promise against stem weevil, a note of caution must be sounded concerning its use. Reports from a farm advisory officer in the Dunedin area state that this insecticide in trials against grass-grub (*Costelytra zealandica*) has caused severe losses of earthworms up to a year after application. This was followed by unthriftiness and loss of soil texture in the "Telodrin"-treated plots. The earthworm species most affected was the common lumbricid, *Allolobophora caliginosa*, shown by the work of Hamblyn and Dingwall (1945) at Raetihi (confirmed by Nielson, 1951) and that of Stockdill (1959) at Hindon to be highly important in pasture production. A destroyed population would require many years in uncontaminated soil before any fresh build-up occurred. There is an urgent need to study the effect of different rates of "Telodrin" upon the earthworm fauna.

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