BIOLOGY AND CONTROL OF BLACK BEETLE

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Summary

A brief account is given of the life-history and habits of the black beetle, *Heteronychus sanctae-helenae* Blanch., in New Zealand, as well as results of insecticidal trials carried out against this insect during 1962-64.

Endrin at 8 and 16 oz per acre, "Telodrin" at 8 and 16 oz, and dieldrin at 4 and 8 oz, all formulated as pellets, gave excellent control of larvae 60 weeks after treatment.

At dosages as low as 2 oz per acre, pelleted endrin, "Telodrin", and heptachlor were highly effective against adult beetles 39 days after treatment.

Treatments against the adult beetle in early spring are considered to be the best method of preventing black beetle damage in pasture.

INTRODUCTION

UNKNOWN in New Zealand prior to 1937, the black beetle, *Heteronychus sanctae-helenae* Blanch., is now a serious pest of pastures in many districts in the northern half of the North Island. In 1957 it was realized that the insect had become a serious threat to the grassland economy in certain areas, and that some effort would be required to reduce its depredations. As little was known of its life-history under New Zealand conditions, it was considered necessary to investigate this before attempting control procedures. A full account of the life-history and habits of the insect, together with data obtained from chemical control trials carried out in 1958, has already been published (Todd, 1959).

The 1958 trials demonstrated that satisfactory control of black beetle in pasture could be secured with dieldrin at 4 oz per acre in superphosphate. (All rates of treatment are expressed in terms of active ingredient per acre.) For practical purposes, however, it was considered that 8 oz should be used. In 1961, Agricultural Chemicals (Insecticide) Regulations severely limited the use of dieldrin/superphosphate on grazing pasture. As a result of this, alternative control measures have been investigated.

This paper presents results obtained from recent trials, together with a brief account of the life-history and habits of the insect.

SEASONAL HISTORY

The main overwintering stage is the adult beetle, but because of a late compound brood which is carried over from one season to the next, it is usual to find pupae, and larvae at various developmental stages throughout this period. Mating takes place in the spring, and eggs are found from about mid-October until early January. They are deposited singly, and are usually found about $\frac{1}{2}$ in. below ground level. Early in the season the incubation period is about 6 weeks but probably decreases later when higher soil temperatures are normally experienced. The larvae pass through

three instars before pupating. The new-generation beetles emerge through March, April, and May, with a small number appearing in February. By June most of these have become dormant, and remain in this condition throughout the winter. They resume feeding in the spring, and continue to feed until December after which there is a gradual decline in numbers as they die off. Most beetles encountered at this time are dead, few live beetles being found between December, and emergence of new generation adults. There is only one generation per year, and during the 12 months' cycle, old-generation beetles are feeding from late September until December, and new-generation beetles from about March until June. The principal feeding period of the larvae is from December until February, and in some cases may continue on into March. On account of varying climatic conditions and seasonal trends, there are probably some variations in the life-cycle of the black beetle from one season to another, and from place to place.

HABITS

The main breeding grounds of the black beetle are grassland pastures, particularly those growing in areas where the soil is either light, sandy, or of a peaty nature. Both the larvae and adults are directly responsible for damage so that pasture deterioration is continuous. Most pasture grasses are open to attack, but legumes are not favoured by the insect. *Paspalum* pastures are particularly susceptible to black beetle damage, and when heavy infestations occur the *paspalum* may disappear completely leaving bare ground and a subsequent invasion of clover, flat weeds, and thistle.

Larvae are not able to endure long periods of submersion in water, and in areas subject to flooding many are drowned. Under these conditions, and to a lesser degree in areas where flooding does not occur, there is a markedly irregular density distribution of larval populations. In peat soil, which usually has a fairly high moisture content, larvae tend to be concentrated in the higher situations where soil conditions are drier. On undulating country which is not subject to flooding they are often found more abundantly on slopes, particularly on those with a northerly aspect. In pastures which are more uniform in vegetation, topography, and moisture content, the larval population is more evenly distributed.

The adult beetles spend a large proportion of their time in the soil, and, when attacking pasture plants, feed mainly on the root system immediately below ground level. They do not appear to be adversely affected by wet conditions and are able to tolerate long periods of submersion in water. The natural, and main spread of the insect occurs in the autumn when large swarms of flying beetles are often encountered, frequently being attracted to certain forms of artificial lighting. Ocean currents and tides also assist in spreading the pest. Often heavy rains wash the beetles into streams and open drains whence they are carried out to sea, some ultimately being driven ashore farther afield.

CHEMICAL CONTROL

In December, 1962, at Te Kaha, a replicated field trial was laid down against the larvae employing endrin, "Telodrin", and lindane at dosages of 8 and 16 oz per acre, and dieldrin at 4 and 8 oz per acre. In view of the considerable interest which was at this time being shown in the use of pelleted insecticides for pasture insect control, prill formulations were employed. In each case the prills were mixed with superphosphate and dry sand. The superphosphate

was applied at the rate of 2 cwt per acre. The sand filler was included in the mix so as to increase the bulk, thus ensuring an even distribution of the prills at time of application. The experiment was laid out as a randomized block with 12 replications of each treatment. The individual plots were 8 ft 3 in. square (1/640 acre) with buffer areas 2 ft wide between plots. The area was close mown and fenced free of grazing stock. The treatments were applied by hand on December 17, and at the time of application, conditions were calm, and the pasture free of moisture. The plots were sampled on February 13, 58 days after treatment. Three samples, each 7 × 7 × 5 in. were taken at random within each plot and the number of living specimens recorded for each sample. The true totals per treatment, and their decoded standard errors, are given in Table 1.

TABLE 1: TRUE COUNTS OF LIVING SPECIMENS 58 DAYS AFTER TREATMENT

<i>Treatment</i>	<i>Rate (oz)</i>	<i>Total Number Living Specimens per Treatment and their S.E.</i>	
Control	—	82	± 7
Lindane	8	88	10
Dieldrin	4	81	10
Lindane	16	69	9
Dieldrin	8	60	8
"Telodrin"	8	37	7
Endrin	8	36	7
Endrin	16	14	5
"Telodrin"	16	14	5

Statistical analysis of the data reveals that dieldrin at 4 oz, and lindane at 8 oz and 16 oz, respectively, did not differ significantly from control, and that all remaining treatments significantly reduced the numbers of live specimens. "Telodrin" at 8 oz was significantly better than dieldrin at the same rate, while both endrin and "Telodrin" at 16 oz were significantly better than all other treatments.

The generally unsatisfactory results obtained from the trial 58 days after treatment was attributed to inadequate rainfall, resulting in slow dispersion, and lack of penetration of the toxicants. To obtain confirmation of this, a second count of larvae was made on February 13-14, 1964, approximately 60 weeks after treatment. The true counts of surviving specimens per treatment, and their decoded standard errors, are presented in Table 2.

The 60-week counts showed that there were no significant differences between control and lindane at 8 oz. Lindane at 16 oz was significantly more effective than lindane 8 oz, and than control. Dieldrin at 4 oz was almost 100% effective and was significantly different from control and lindane treatments. All other treatments were completely effective.

In December, 1963, at Te Kaha, a trial was undertaken to compare the effectiveness of pelleted formulations of heptachlor, "Telodrin", and dieldrin with wettable powder forms of the same materials. The experimental procedure and sampling technique were the same as for the 1962 trial. Treatments were carried out on December 4 and the materials employed were in each case

TABLE 2: TRUE COUNTS OF SURVIVING SPECIMENS 60 WEEKS AFTER TREATMENT

<i>Treatment</i>	<i>Rate (oz)</i>	<i>Total No. Living Specimens per Treatment and their S.E.</i>		
Control	—	179	±	13
Endrin	16	0		
Endrin	8	0		
"Telodrin"	16	0		
"Telodrin"	8	0		
Dieldrin	8	0		
Dieldrin	4	6		2
Lindane	16	102		19
Lindane	8	175		19

TABLE 3: TRUE COUNTS OF SURVIVING SPECIMENS 70 DAYS AFTER TREATMENT

<i>Treatment</i>	<i>Rate (oz)</i>	<i>Total No. Surviving Specimens per Treatment and their S.E.</i>		
Control	—	279	±	13
Heptachlor (prill)	8	149		18
Heptachlor (wetable powder)	8	200		18
"Telodrin" (prill)	8	188		18
"Telodrin" (wetable powder)	8	164		18
Dieldrin (prill)	8	244		18
Dieldrin (wetable powder)	8	226		18

applied at 8 oz per acre. The plots were sampled on February 11-12, 1964, 70 days after treatment. The true counts of surviving specimens, and their standard errors, are given in Table 3.

An important feature of the results was the failure of all materials in any of the forms used to give effective control. As little rain fell in the trial area during the 70-day period, it is concluded that this factor was primarily responsible for their ineffectiveness.

As a fresh approach to the problem, a field experiment was laid down in September, 1963, to test a selected range of chemicals against the adult beetle. The materials employed included prill formulations of endrin, "Telodrin", dieldrin, lindane, heptachlor, diazinon, DDT, and coumaphos. The experiment was conducted in wooden frames 2 ft $\frac{3}{4}$ in. square (1/10,240 acre) set in paspalum pasture to a depth of 4 in. All treatments were applied at 1 lb per acre and replicated 3 times. Six untreated plots were used as controls. On September 14-15, 20 beetles were introduced to each plot. The beetles quickly burrowed into the ground. Each frame was covered with galvanized "fly gauze" to prevent the beetles from escaping. Treatments were carried out on September 16 and in each case the necessary quantity of insecticide was mixed with dry sand and applied with a salt-shaker. Following treatment, $\frac{1}{2}$ gal of water was applied to each plot by watering-can in order to wash toxicants into the surface layer of soil. The true percentages of beetle mortality per treatment after 36 days are given in Table 4.

TABLE 4: TRUE PERCENTAGES OF BEETLE MORTALITY 36 DAYS AFTER TREATMENT

<i>Treatment</i>	<i>Rate (lb)</i>	<i>Percentage Mortality</i>
"Telodrin"	1	100.0
Heptachlor	1	98.8
Dieldrin	1	97.7
Endrin	1	97.3
Lindane	1	96.3
Diazinon	1	50.7
DDT	1	12.0
Coumaphos	1	2.2
Control	—	7.3

The results of the experiment showed that DDT and coumaphos were ineffective, diazinon partially effective, and "Telodrin", heptachlor, dieldrin, endrin, and lindane all highly effective.

Further experimentation with the highly effective materials at dosages of 2, 4 and 8 oz per acre was undertaken in March, 1964. The experimental procedure was the same as for the earlier trial with the exception that 30 beetles were introduced to each plot. Treatments were carried out on March 7, and a count of beetle numbers was made between April 14 and 16, approximately 39 days after treatment. Results are given in Table 5.

Statistical analyses of the results showed that all treatments were significantly better than control except lindane 2 oz. Within the materials, there were significant improvements at the higher rates of application of lindane and dieldrin only. In the other materials, where the kills at the lowest rates were better than in lindane and dieldrin, the improvements by stepping up the application rates did not reach the significance level. At the 2 oz rate of application, "Telodrin" was significantly more effective than endrin, dieldrin, and lindane. At the 4 oz rate of application, "Telodrin"

TABLE 5: TRUE PERCENTAGE OF BEETLE MORTALITY 39 DAYS AFTER TREATMENT

<i>Treatment</i>	<i>Rate (oz)</i>	<i>Percentage Mortality</i>
Endrin	8	96.3
Endrin	4	90.2
Endrin	2	84.9
"Telodrin"	8	100.0
"Telodrin"	4	97.2
"Telodrin"	2	96.3
Dieldrin	8	94.4
Dieldrin	4	71.6
Dieldrin	2	61.2
Lindane	8	90.2
Lindane	4	86.0
Lindane	2	28.8
Heptachlor	8	94.7
Heptachlor	4	85.3
Heptachlor	2	88.9
Control	—	10.7

was significantly more effective than dieldrin, lindane, or heptachlor. At the 8 oz rate of application, "Telodrin" was significantly better than all treatments since there was a zero survival in this treatment.

DISCUSSION

Dieldrin has been recommended for some years for control of black beetle in pasture. Most of the usage has been in the form of dieldrin mixed with superphosphate. From the residue point of view, the desirability of utilizing pelleted forms of insecticide for black beetle control needs no elaboration. Such formulations of endrin at 8 oz per acre, "Telodrin" at 8 oz, and dieldrin at 4 oz all gave excellent results when applied against the larvae. Although no positive results were obtained with these materials until 60 weeks following their application, the writer is of the opinion that the effect of the treatments after 58 days, when the initial assessments were made, would have been much greater had the rainfall during this period been adequate to promote penetration of toxicants.

Wettable powder, and pelleted formulations of heptachlor, "Telodrin" and dieldrin were included in a trial to compare their effectiveness against black beetle larvae. All treatments failed to give effective control after 70 days. As little rain fell in the trial area during the 70-day period, lack of penetration of the materials was almost certainly a significant factor in their ineffectiveness.

In pelleted form endrin, "Telodrin", dieldrin, lindane, and heptachlor, all proved toxic against black beetle adults. In the case of endrin, "Telodrin", and heptachlor, rates as low as 2 oz per acre gave a highly effective kill of beetles.

The effectiveness of an insecticide treatment against black beetle in pasture depends very much on whether there is sufficient rainfall following treatment to wash the toxicant into the soil. In the case of the adult beetle which normally feeds at, or near ground level, it is logical that the requirements of rainfall for adequate penetration of toxicants would be minimal. In view of this, and the fact that the adult is susceptible to low dosages of insecticide, it must be conceded that adult beetle control is the best approach to the problem. Effective treatments against the adult in early spring (before mid-September) would prevent egg laying, and subsequent damage by larvae.

ACKNOWLEDGEMENTS

The writer is indebted to A. C. Glenday, Applied Mathematics Laboratory, D.S.I.R., for the statistical analysis of the trials, and to the firms who supplied the various insecticides.

REFERENCE

- Todd, D. H., 1959: Black beetle *Heteronychus sanctae-helenae* Blanch., in pastures in New Zealand. *N.Z. J. agric. Res.*, 2: 1262-73.