GRASS GRUB CONTROL

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Farmers throughout New Zealand agree that grass grubs, or the larvae of *Odontria zealandica,* are the most serious insect pests of pasture. Though damage is not conspicuous every year in established pasture, there is usually a certain amount of annual thinning out of valuable fodder plants and their replacement by weeds such as plantain, dandelion, mouse-eared chickweed, and weed grasses such as sweet vernal and hair grass. It is difficult to estimate losses involved in this way except by close inspection of pastures or by a fall in farm returns. For example, one dairy farm in the Waikato produced over 80001b. less butterfat this year than last, and yet it was only after a careful inspection that it was found that these pastures-though they looked uniform from a distance-had deteriorated by approximately one third. Though no definite sequence of grass grub damage can be predicted, it is common for an infestation to build up over a period ranging from 1 to 8 years, with damage becoming progressively worse from an original patchy effect till the pasture is more or less uniformly infested.

There are various controlling agents-some natural, some artificial-each exercising a low or comparatively high degree of control, but the overall effect of natural controlling agents is not sufficiently great to prevent build-up of infestations to a dangerous level.

Of the natural factors in control there are several native insects (carabid beetles and asilid flies), a bacterium, and a nematode ; as well as insects (thynnids) , a bacterium, and a nematode introduced from overseas. The native parasites are sometimes found to exercise reasonably high degrees of control in localised areas, but the fact that they do not materially reduce the overall grub population shows that they cannot be relied on. Of the introduced parasites the insects are the only ones that have been liberated on a reasonably large scale, and though at least two species of them attack our grass grubs in the field it will be many years before a reliable estimate of effectiveness can be made. One species has been recovered in the field during each of the two years following liberation, and this is rather unusual and gratifying at this early stage. The introduced nematode has given excellent control under laboratory conditions in New Zealand, but no field liberations have been made.

The natural factor that is perhaps the main one governing population densities of grass grubs is that they are markedly cannibalistic during the second and third stages of development. This can be shown readily under laboratory conditions by varying the amount of vegetable matter in soil in a given size of container. Under farm conditions a vigorous and dense root system can harbour a higher grub population than can a weak root system. As the root supply is depleted larvae become concentrated round remaining food sources, with the result that they come in contact with one another. Under such conditions it has been found that cannibalism can result in over 98 per cent. reduction in grub populations. This cannibalistic tendency is possibly the main reason why grub populations are in general lower in very poor, discontinuous pastures than in strong, continuous pasture. In Canterbury it can be shown that irrigated pasture often harbours higher populations than does non-irrigated land, without showing the same extent of damage.

It is sometimes possible to prevent grub damage by modifications of normal farm management, though these are not control methods in the strict sense. This is illustrated by the sowing of cruciferous crops either so early that they are in the six-leaf stage (including seed leaves) by November 1, or delaying sowing till the end of December. This is to avoid losses due to feeding by beetles when they fly during November and December.

Also it has been found that pastures that have been severely damaged can be saved on flat land by the use of rollers of from 6 to 12 tons. The rolling does not, however, reduce grub populations beyond the danger level, as the crushing effect on larvae is extremely small. The rolling should therefore be done at a time when grub activity is decreasing, so that they do not again cause damage to roots. In Canterbury it is possible to secure excellent pasture recovery by rolling between May and the end of August. At this time the larvae have reached a peak of activity and from then their numbers tend to decrease and 'they are approaching the fully fed state. The rolling consolidates the ground that has been disturbed by passage of grubs in soil and pushes loosened tufts of grasses back into the soil where they will re-root successfully if stock is left off for at least three weeks after rolling. Top growth of pastures practically ceases in Canterbury when soil temperatures fall below 45 degrees F., but roots develop 'when temperatures are well below this point. One farmer on grub-damaged irrigated land rolled pasture early in April, and though grub activity continued till August achieved excellent recovery. It is important to use rollers when there is a plentiful supply of soil moisture; rolling when ground is dry is useless, moisture being essential for adequate soil compaction, for root growth, and to assist to a certain extent in crushing the grubs. If rolling is left in Canterbury till September, which is often a dry month, the soil dries out rapidly and north-west winds dry up injured pasture so that recovery is impossible. Rolling should be carried out as soon as it is possible to take heavy rollers and tractors over the ground. With this type of treatment, however, it is important to remember that though the pasture can be saved the insects are still present and will appear as adults at the normal time. The fact that pasture has been maintained in good condition will almost certainly result in the beetles laying most of their eggs in the same paddock. This means that close watch will have to be kept on rolled pasture in subsequent years so that the same treatment can be applied when damage begins to appear. It is considered improbable that grub populations would go on building up if rolling were repeated year after year on the same ground. The cannibalism factor, quite apart from native parasites, would ensure a population level above which it would be impossible to increase.

CONTROL

Low-volume DDT sprays (3 and 4 gallons per acre) on 16 acres gave excellent coverage to treated pasture, but there was insufficient spray to carry insecticides on to the ground surface where they were required for maximum effect. Collections of emerging beetles showed that the collection made before sheep commenced grazing the treated area was the only one that was significantly better than untreated zones.

Sheep grazing apparently removed almost the entire insecticide deposit,. Sampling showed that there were no significant differences in larval counts on treated and untreated plots.

Moderate-volume sprays (160 to 240 gallons per acre) were adequate to carry most of the insecticides to the soil surface with the rather poor grade pasture treated. Counts of emerging beetles showed that BHC was significantly better than DDT at a rate of $1\frac{1}{4}$lb. of 100 per cent. active constituent per acre. Sampling for larvae showed that both BHC and DDT were significantly better than controls, and that BHC was slightly the better.

High-volume sprays (1200 to 1500 gallons per acre) using $\frac{1}{2}$ and llb. dosages per acre of the insecticides BHC, DDT, Rothane, Chlordan, Parathion, and sodium pentachlorphenate have given good results against both beetles and larvae in some cases. Pasture cover was analysed by the point analysis frame and by visual estimation by three officers, and an average of larval counts and point and visual analysis figures showed that BHC was 85.8 per cent. and DDT 80.2 per cent. better than untreated plots.

Statistical analysis showed that:

1. There were no significant differences between the two dosages ($\frac{1}{2}$ and llb. per acre) of any insecticides on point and visual analysis figures for July treatments, but the top dosage was significantly better at the 5 per cent. level for July beetle collections, at 1 per cent. level for larval counts for July treatments, and at 1 per cent for all four methods of analysis of November treatments. Parathion was not significantly better than controls at any point, and sodium pentachlorphenate also was no better than untreated plots except for beetle collections on November applications, where it was better than controls at the 1 per cent. level.

2. BHC, DDT, Rothane, and Chlordan were significantly better than sodium pentachlorphenate, Parathion, and controls at the 1 per cent. level by all four methods of analysis.

3. BHC, DDT, and Rothane were significantly better than Chlordan at the 1 per cent. level for all four methods of analysis on July treatments, and total beetle collections and visual analysis on November treatments. They were not significantly better than Chlordan on larval counts for November, but were

better at the 5 per cent, level on point analysis figures for November.

4. BHC and DDT were significantly better than Rothane at the 1 per cent. level for both July and November beetle collections, and at 1 per cent. for larval counts on July treatments and 5 per cent. for November larval counts. They were better at the 5 per cent. level than Rothane on both treatments on point analysis figures, and at 5 per cent. for the November visual analysis figures, but not significantly better on visual analysis figures for July.

5. DDT was significantly better than BHC at the 1 per cent. level for November collections of beetles, but there were no significant differences between these two insecticides at any other points in the four methods of analysis.

Treatments in March, May, and December, 1947, using DDT and BHC as dusts permitted good pasture recovery, but it was not possible to determine the full effect over a complete year, as the paddocks were ploughed up. Superphosphate treated with DDT and applied in July, 1947, gave only fair control the first year, but retained its effectiveness and permitted better pasture recovery the second year after application. Ten acres treated against both *Oxycanus (Porina)* caterpillars and grass grubs with average populations of 20 and 29 per sq. ft. respectively showed that 0.85lb. of 100 per cent. gamma BHC in lcwt. of superphosphate permitted a 100 per cent. and 0.42lb. per acre a 75 per cent. pasture recovery; and 1.6lb. of 100 per cent. DDT in 1cwt. of superphosphate a 70 per cent. pasture recovery, with only 20 per cent. on untreated areas to which straight superphosphate had been applied. The second year the paddock again became infested by both grass grub snd *Oxycanus*, and the insecticides had retained part of their effectiveness, as shown by the fact that the 1.6lb. per acre and 0.8lb. dosages of DDT reduced the grub populations to 2.2 and 7 per sq. ft. respectively, and the *Oxycanus* numbers to 0.06 and 0.96 for respective dosages. The BHC, though still effective at the top dosage, had not retained its effectiveness to the same degree as DDT, as the grub numbers were reduced to 4.7 and 8.7 and the *Oxycanus* to 3.4 and 6.6 per sq. ft. for the 0.8 and 0.4lb. per acre dosages respectively. There were averages on untreated areas that had received superphosphate only of 12.4 grubs and. 4 *Oxycanus* caterpillars per sq. ft. Pasture cover was

93 per cent. on the 1.6lb. DDT, 92.8 per cent. on the 0.8lb. DDT, 75 per cent. on the 0.85lb. BHC, 54.25 per cent. on the 0.4lb. BHC, and 49.8 per cent. on untreated areas the second year after application. The DDT, therefore, was practically as good the second year as the first against both insect pests, and will almost certainly be an effective controlling agent for a third year also.

Precautions to be observed and tested are:—

1. With sprays, large amounts of insecticides remain on pastures; this has two disadvantages.
   (a) They are eaten by stock and so are ineffective against grubs.
   (b) They may cause taint of animal fats and butterfats.

2. For best results apply insecticide-treated superphosphate
   (a) when pasture is close-grazed.
   (b) when pasture is dry, to avoid adherence of insecticides to pasture.

3. Do not apply insecticide mixtures or sprays to clovers etc., when in the flower bud, or full bloom stages, or pollinating agents such as bees, moths, etc., would be killed.

4. If breezes are blowing, hang canvas or sacking curtains behind the drill or topdresser to prevent loss of insecticide.

DDT and BHC are not soluble in water, so it is unlikely that they will be taken up into plant tissues through root systems.

Costs of treatment by DDT and BHC at the 1lb. per acre dosages were 12s. 6d. and £1 10s. 10d. an acre respectively for insecticide alone.

For forest and other nurseries, and playing areas such as golf, tennis, bowling, croquet, and home lawns, where a higher cost was not a disadvantage, excellent control was secured by the use of 1½lb. of 50 per cent. DDT per 1000 square yards of lawn. The insecticide was mixed either with 611b. of dry sand or soil, or with 61lb. of the usual lawn topdressing (3 parts of ammonium sulphate and 1 part of superphosphate) and applied at a rate of loz. per square yard of lawn. This treatment should proof lawns for at least 3 years against the three common species of grass grubs ***(O. zealandica, O. smith/ii, O. striata)*** and also *Oxycanus* caterpillars. For best results with the latter the area to be treated should be raked lightly to remove caterpillar casts before insecticides are applied.

Application of DDT and BHC can be made at any time to suit the convenience of farmers if they bear in mind that clover seeding will be affected if they are applied when these plants are in flower. Applications from August to November will give positive results in late February and March the next year, whereas treatments in January to March will not give good results till the following February and March. This is because the third stage of grubs is relatively immune from these insecticides and the first two stages are susceptible.

The various DDT and BHC formulations apparently give equally good results at equivalent dosages, and methods of application, whether as dusts, sprays, in fertilisers, or in sand also give uniform results provided the insecticides come in contact with the soil surface.