THE CONTROL OF THE COMMON CATTLE GRUB, *Hypoderma lineatum* (De Villers) WITH SYSTEMIC INSECTICIDES

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PREFACE

While the author was taking courses in vocational agriculture in high school, the standard but far from ideal treatment for the control of cattle grubs was rotenone dust. The advent of the animal systemic insecticides has done much to alleviate the cattle grub control problem. Having a farm background the author was very interested in the possibility of the success of the systemics when administered as a feed additive, bolus, top line, or complete cover spray. With these aims in mind an experiment was designed in consultation with Dr. Howell to find how effective the systemic insecticides are when administered in the various ways.

The author wishes to express his deep appreciation to his major advisor, Dr. D. E. Howell, Professor and Head of the Department of Entomology, for his patience, advice, and counsel in planning the experiment and preparing this thesis. The assistance and suggestions of Dr. F. A. Fenton, Professor of Entomology and Head Emeritus of the Department of Entomology; G. A. Bieberdorf, Assistant Professor of Entomology; Dr. J. E. Webster, Professor of Biochemistry, were invaluable. Special thanks are given to Warren F. Pippin, Captain, U.S.A.F.; Victor Zeve, graduate student in entomology; Grant Kinzer and Leo Wynn, entomology students, for their help on the project. Acknowledgement is made of the wholehearted cooperation of the personnel of the Fort Reno Livestock Research Station; El Reno, Oklahoma, and the Southern Great Plains Field Station; Woodward, Oklahoma.

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CHAPTER I

INTRODUCTION

Loss From Grubs

The cattle grub, or ox warble, is one of the most harmful pests of cattle. The grub causes loss to the rancher or dairyman in three different ways--damage to the hide during the grub season resulting in lower grades and prices, loss of meat in dressed carcasses where portions of meat contaminated by grubs and secondary invaders have to be removed, and loss of weight and decreased milk production, estimated at 10 to 20%, caused by the cattle running from the flies. The average annual loss to cattle producers from cattle grubs is estimated at 100 million dollars annually (U. S. Dept. Agr., Agr. Res. Ser., 1954).

History of Control

There are a number of different natural controls that tend to reduce the grub population. When the grubs are on the ground; chickens, birds, and small rodents may eat a large number of them. When the soil is wet beneath the pupa, high mortality occurs. Strong winds also reduce the number of eggs the adult flies can deposit (Bishopp and Laake, 1949).

The grub is difficult to control because of its biology. The heel fly emerges while the cattle are on the range and in pastures and has

enough food left over from the grub stage to last through adulthood without feeding. The egg hatches in 3 to 4 days after being oviposited. The body of the host provides perfect protection for the young grub after it has gained entrance. These disadvantages to control are offset by the fact that the insect has no other major host, the flies do not migrate very far, and the period in which grubs can be found in the backs of cattle is only 4 or 5 months in the winter and spring (Bishopp and Laake, 1949).

Many different avenues of approach have been used in attempting to find a satisfactory control for the grub; repellents have been applied to the legs and lower portions of the cattle affording very little protection, dark sheds have been provided for the cattle during the period of egg deposition, and the grubs have been extracted by hand. By means of hand extraction most of the grubs can be removed, but it is time consuming, and a hole has already been cut in the skin. The backs of cattle can be treated with insecticides either by spraying, brushing, or dusting (Laake and Roberts, 1952).

Life History and Habits

There are two distinct species of cattle grubs. One is found throughout the entire United States and is called the common cattle grub, Hypoderma lineatum (De Vill.). The other species is called the northern cattle grub, Hypoderma bovis (L.), because at the present time its distribution is roughly limited to the northern half of the United States. The habits of the two species of grubs are very similar in characteristics and life cycle (Bishopp and Laake, 1949).

Oviposition starts with the first warm sunny days of spring. The majority of the eggs of both species are oviposited on the hind legs of

the cattle below the knees. The fly does no stinging while the eggs are being deposited, but the tickling or buzzing usually excites the cows causing much nervousness and running with their tails held high in a characteristic manner. Each female fly is capable of laying about 500 eggs during her life span, which is usually less than 25 days depending on the temperature (Roberts and Lindquist, 1956).

The eggs are yellowish white and are attached singly by Hypoderma bovis (L.) and in a group by Hypoderma lineatum (De Vill.). In three to four days the eggs hatch, and the larvae, by emzymatic action, start to digest the skin, thus gaining entrance into the body. This results in much irritation and stomping by the animal. The young grubs work their way upward between the leg muscles of the animal and in a few months may be found in the abdominal and chest cavities. During the following 7 or 8 months they constantly migrate over the surface of the paunch, intestines, spleen, and other organs. The grubs at this time are small and slender, about one-tenth to six-tenths of an inch in length. In the fall, winter, and spring the grubs migrate through the muscular tissue of the back and in a short time reach the under surface of the skin. During the migration some of the grubs enter the spinal canal and may burrow along the spinal cord. Soon after reaching the skin a small hole is cut (Howell, 1958).

When the grub reaches the skin, it is still slender and about six-tenths of an inch long. One to five days after reaching the skin the grub molts for the first time. Following this molt the skin of the grub becomes closely set with spines. The host at this time also starts to form a cyst or pocket around the grub. After the first molt the growth is rapid, and the second molt occurs 25 days later. At the end of 35 to

45 days the grub works its way out from just under the skin through the breathing hole and falls to the ground (Bishopp and Laake, 1949).

When on the ground, the grub seeks the protection of any material at hand. From 12 to 48 hours after the grub leaves the host, the hard, black pupal case is formed. The pupal stage lasts from 18 to 77 days for the southern heel fly and from 15 to 25 days for the northern heel fly. Upon emergence from the pupal case the female is ready to mate and after mating may start laying fertile eggs the same day. The adult flies have enough food stored up from the larval stage to last through their short life span, thus making it unnecessary to feed as adults (Roberts and Lindquist, 1956).

CHAPTER II

REVIEW OF LITERATURE

The acute need for an animal systemic insecticide for more effective control of ectoparasites and endoparasites of livestock has been recognized for many years. Various workers, for many years, have been testing the external and internal administration of many insecticides in the hope of finding one with systemic properties.

One of the earliest workers in this field was Parman et al. (1928) who fed flowers of sulphur to three chickens in the hope of controlling the ectoparasites that were feeding on them. The first hen received 1 gram, the second 2 grams, and the third 4 grams, daily. At the beginning of the test the hens weighed 2 lb. and 14 oz., 4 lb., and 3 lb. and 12 oz., respectively. At the end of the 31 day test the first hen had gained 3 ounces, the second 1 ounce, and the third hen had lost 5 ounces. At the close of the tests, infestations of the body louse, shaft louse, and head louse were essentially the same as at the beginning. Larvae of the fowl tick, Argas persicus (Oken), were applied to the hens, 100 on the first hen, 11 of which engorged; 100 on the second hen, 15 of which engorged; and 200 on the third hen, 28 of which engorged. There was no indication of louse or tick eradication in spite of the sulphur fed to the chickens.

Emmel (1937) reported that poultry lice were apparently controlled when birds were fed sulphur and kept outdoors in cages. Extensive

experiments by Creighton et al. (1943) with housed chickens gave negative results. They reported no control with internal application of sulphur. Limited control was obtained by incorporating 5 to 10% sulphur by weight into the feed, but good control was obtained when the chickens were dusted with the feed mixture. The chickens dusted with a sulphur dust and others dipped in a sulphur solution also showed good control.

Sulphur was tested for the control of ectoparasites on goats and cattle by Babcock et al. (1943). Sulphur was fed in capsule form to goats and cattle over a period of 247 days at the maximum rate of 5 grams for each 100 pounds of body weight. The sulphur was not effective against any of the following ectoparasites: red biting louse of goats, Bovicola caprae (Gurlt) and B. limbatus (Gerv.); the hair goat louse, B. penicellata (Piaget); blue sucking louse, B. scalaris (L.) and Linognathus stenopsis (Burm.); and spinose ear tick, Otobius megnini (Dugés). When two of the calves and three of the goats were slaughtered, they were declared fit for human consumption. Live, mature stomach worms, Haemonchus contortus, were found in the stomach of one of the slaughtered goats.

The effectiveness of phenothiazine for the control of horn fly larvae in manure was determined by Knipling (1938) and Bruce (1939). When various quantities of the chemical were mixed with bran and this mixture fed to cows, the minimum dose of phenothiazine that killed all the horn fly larvae was 22 mg./kg. of animal weight. This dose rendered the manure unfavorable for the development of horn fly larvae for approximately 24 hours beginning 12 hours after treatment. When phenothiazine was mixed directly with the feces, the minimum lethal dose was 4 mg./100 grams of feces.

Schwartz et al. (1955) reported observations in which the free choice administration of phenothiazine appeared to cause a reduction in the number of grubs reaching the backs of medicated cattle as compared to the non-medicated controls. In the first trial, 3 controls had a total of 82 grubs, and 3 medicated animals had a total of 11 grubs. In the second trial, 6 controls averaged 36 grubs per animal, and 6 medicated animals averaged only 8 grubs per animal. The difference of 28 grubs per head between the treated and nontreated animals was statistically significant, but it was suggested that additional experiments would have to be performed before a conclusive statement concerning effectiveness of phenothiazine as a control for the cattle grub could be made.

In the 1956-57 grub season, Howell (1958) worked with 2,000 head of cattle in Oklahoma in an effort to determine the effectiveness of phenothiazine for cattle grub control. The data were statistically analyzed and showed no significant differences between the grub population of the treated and untreated animals. Cobbett (1957) obtained similar results when he incorporated 2 to 4 grams of phenothiazine daily into the feed of a small number of cattle. This treatment appeared to reduce the incidence of infestation; however, when tested on a larger scale involving many more animals, no significant difference in the number of infested animals or in the number of grubs per animal was observed.

Roberts (1957) incorporated 2 grams of phenothiazine and 10 mg. of stilbesterol, singly and combined, into the daily ration of the cattle as a control for the larvae of the cattle grub. The treatment caused no difference in the time the grubs arrived in the subcutaneous tissue nor in their survival while in the cysts.

Arsenic injections to control horn flies on cattle were tried by Bruce (1940). A heifer was treated with an intravenous injection of a commercial form of trivalent arsenic (meta-amino-para-hydroxyl phenyl arsine oxide) used in antisyphilitic therapy. The arsenical was reported to have no apparent effect on horn flies that fed on the animal, nor was it effective against screw-worms. The toxicity of the feces to the horn fly larvae was varied.

Experiments to determine the value of zinc oxide (ZnO) in preventing the development of the horn fly larva, Siphona irritans (L.), in cattle droppings were conducted by Bruce (1942). When various quantities of the chemical were mixed with bran and fed to the cattle, the minimum effective dosage was 1.5 grams per 100 pounds weight of the animal. This dose rendered the droppings unfavorable for development of horn fly larvae for 25 hours beginning 20 hours after treatment. When zinc oxide was administered directly to the droppings, the minimum lethal dose was 0.01 grams for each 100 grams of droppings.

Lindquist et al. (1944) found that rabbits dosed with 228 to 400 mg./kg. of DDT gave 100% mortality to bedbugs, Cimex lectularius (L.) and C. hemipterus (F.), three to five hours after treatment. Rabbits treated with pyrethrum showed similar results. Knock-down was faster, but a few insects recovered several hours after treatment. Stable flies, Stomoxys calcitrans (L.), also showed typical pyrethrum paralysis in less than a minute. Dosages of 250 to 400 mg./kg. did not appear injurious to the rabbits.

An extensive evaluation of selected insecticides and drugs used as chemotherapeutic agents for the control of bloodsucking external parasites, when fed to rabbits was performed by Knipling et al. (1944).

Thirty-three different drugs and insecticides were tested for the control of the body louse, Pediculus humanus humanus L.; yellow fever mosquito, Aedes aegypti (L.); ear mite, Psoroptes equi var cuniculi (Delafond); and the lone star tick, Amblyomma americanum (L.). The only good results were with 2-pivalyl-1, 3-indandione against lice and ticks and gamma benzene hexachloride against mosquitoes.

Eddy et al. (1954) at Kerrville, Texas, observed insects living on the blood and manure of cattle that had been fed certain chlorinated hydrocarbons. The cattle were fed the following insecticides at indicated levels for different periods of time: lindane (gamma isomer of BHC[1,2,3,4,5,6-hexachlorocyclohexane]) at 10 and 100 p.p.m. for 84 days; dieldrin (1,2,3,4,10,10-hexachloro-6-7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-exo-5,8-dimethanonaphthalene), aldrin (1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo-exo-5,8-dimethanonaphthalene), and chlordane (1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene) at 25 p.p.m. for 26 days; and toxaphene (chlorinated camphene having a chlorine content of 67-69%) and BHC (12% gamma) at 100 p.p.m. for 112 days. Observations were made on the horn fly, Siphona irritans (L.); common cattle grub, Hypoderma lineatum (De Vill.); house fly, Musca domestica L.; secondary screw-worm, Callitroga macellaria (F.); and screw-worm, Callitroga hominivorax (Cqrl.). Bloodsucking adults were allowed to feed on the treated animals, and house fly, horn fly, and stable fly larvae were reared on manure from the host animals.

Lindane at 100 p.p.m. was effective against the horn flies for 21 days after the 80 day treatment ended, and the manure was toxic to the horn fly larvae. At 10 p.p.m. lindane and BHC were ineffective against the house fly larvae in manure. Manure from the cattle fed dieldrin and

aldrin at 25 p.p.m. was toxic to larvae of the house fly, horn fly, and stable fly. Manure from the animals fed toxaphene and chlordane was nontoxic to the horn fly and house fly larvae. Neither lindane, aldrin, dieldrin, or chlordane had any effect on the common cattle grub.

Radeleff (1951) fed lindane to cattle at 1, 10, and 100 p.p.m. to see if lindane used as an internal medication against insects had any harmful effects on the animals thus treated. The level of intake of lindane in the feed was almost directly reflected in the level produced in the fat of the animal after 70 days of feeding. The stored lindane was shown to be metabolized or otherwise eliminated at a rapid rate; the rate being roughly proportional to the quantity stored. When lindane was fed to cattle at the indicated levels for 84 days, it caused no significant interference with the health, weight gain, or efficiency of utilization of feed.

The effectiveness of lindane, dieldrin, aldrin, allethrin, and heptachlor as animal systemic insecticides when administered subcutaneously to cattle was demonstrated by Lindquist et al. (1953). Aldrin and dieldrin at 25 mg./kg. gave poor kills of tabanids and mosquitoes. Allethrin at 100 mg./kg. and heptachlor at 25 mg./kg. were also comparatively ineffective. Lindane, however, at 75 mg./kg. was toxic to mosquitoes up to 21 days after treatment. It was less effective against deer flies, 40 to 100% mortality occurring for several days. Lindane was not very effective on other tabanids, but horn flies, Siphona irritans (L.), were eradicated in the experimental herd of animals.

The effectiveness of dieldrin injected subcutaneously as a 5% suspension in peanut oil at 25 mg./kg. as a control for the cattle grub was determined by Roth et al. (1955). The first injection killed 78 of

101 grubs present at the time of treatment, but it required from 10 to 28 days to show its effect. None of the larvae which pupated from the treated animals emerged as adults. Apparently, two treatments will control grubs for the entire season, but it fails to prevent the larvae from encysting and cutting holes in the backs of the animals.

McGregor (1955) got similar results working with dieldrin, aldrin, and lindane. It was found that when the insecticides were administered orally at a level which was lethal to the grubs the cattle were killed; therefore, a subcutaneous injection of these materials must be used. Dieldrin and aldrin persist in the fat much longer than the lindane--all may cause an objectional fat contamination for more than a month. Bann (1956) found that aldrin is largely and readily converted to dieldrin in the bodies of beef and dairy cattle. The change of aldrin to dieldrin is apparently independent of the site of entry of the toxicant into the body, as it was found following oral and subcutaneous injections. Dieldrin is stored unchanged in the body and is recovered as such from animal products and body tissues.

Thirteen chemicals were tested by Adkins et al. (1955) to determine their toxicity to domestic rabbits and to certain bloodsucking ectoparasites that feed on them. The ectoparasites were fifth instar bedbugs, Cimex lectularius L., and nymphs of the lone star tick, Amblyomma americanum (L.). Bayer L 13/59 (0,0-dimethyl 2,2,2-trichloro-1-hydroxy-ethylphosphonate) at 200 mg./kg., Bayer 18/178 at 130 mg./kg., and Bayer 21-116 at 95 mg./kg. caused 100% mortality to bedbugs and ticks feeding on the rabbits. The administration of hexamethylphosphoramide at 1,300 mg./kg. resulted in 63% mortality of bedbugs and 100% mortality of ticks. Schradan at 20 mg./kg. had no apparent

effect on ticks but killed 100% of the bedbugs feeding on the dosed rabbits. Eight chemicals failed to kill the test arthropods at levels which were nontoxic to the rabbits. The following insecticides were ineffective: Bayer 21-199 at 110 mg./kg., chlorothion at 375 mg./kg., malathion at 800 mg./kg., and diazinon (0,0-diethyl 0-[2-isopropyl-4-methyl-6-pyrimidinyl]thiophosphate) at 20 mg./kg.

Further work with animal systemics on rabbits was performed by Adkins et al. (1957). Dipterex administered at the rate of 40 mg./kg. gave 95% mortality to bedbugs within one hour after treatment and 100% mortality within two hours after treatment. Fifth instar nymphs of the Gulf Coast tick which fed on rabbits dosed with 100 mg./kg. of Dipterex were completely eliminated.

Diazinon administered by subcutaneous injection at 5, 10, 25, and 50 mg./kg. gave complete kill of cattle grubs present at the time of treatment and also to new ones appearing for a period of two weeks. No dosage gave good control after three weeks (McGregor et al., 1954). When applied as a 1 or 0.5% solution by brushing, good control was obtained (Smith et al., 1954).

McGregor et al. (1954) working with Bayer L 13/59 found that subcutaneous injections of the compound at the rate of 25, 50, and 100 mg./kg. gave excellent control of grubs present at the time of treatment. At 100 mg./kg. the killing of all new grubs was noted two weeks after treatment. Smith et al. (1954) found that brushing a 1 or 0.5% solution on the animal gave good control of grubs.

Bayer 21-199 administered by subcutaneous injection at 25 mg./kg. was completely ineffective against cattle grubs at the time of treatment and during the four weeks observation period. McGregor et al. (1954)

and Smith et al. (1954) found when it was used as a wash of 0.5 or 1% solution, good control resulted. Graham (1957) applied Bayer 21-199 as a spray in the following concentrations: 0.25, 0.50, and 0.75%. An average of 44 grubs per animal was found on the untreated animals while 46 of 48 treated animals were grub free.

To test the feasibility of using Bayer 21-199 as an effective control against screw-worms on sheep an experiment was conducted by Brundrett (1957). It was found when a 0.25 or 0.50% spray was applied to wounded or infested animals it gave excellent protection against screw-worms. Of 5,000 treated sheep less than 1% were infested with screw-worms.

Hewitt et al. (1957) found that American Cyanamid compound number 12-880 would kill all three instars of Hypoderma lineatum (De Vill.). The compound was administered orally or intramuscularly in single doses of 10 to 15 mg./kg. A dose of 40 to 60 mg./kg. produced severe but non-fatal symptoms of cholinesterase inhibition. The dose of 10 to 15 mg./kg. was also effective against second and third instar larvae of H. bovis (L.). It killed both migrating and encysting grubs within two weeks after treatment.

Dow ET-58 was administered to cattle in Oklahoma as a drench at the rate of 40 mg./kg. and gave approximately 70% control. Mild symptoms of toxicity appeared in some of the animals (Taylor, 1957).

Dow ET-59 was administered as a drench made from 25% wettable powder at the rate of 35 mg./kg. This compound was very successful since it gave over 90% control of the cattle grubs. Severe symptoms of toxicity appeared in some of the treated animals, and two died as a result of treatment (Taylor, 1957).

Crenshaw (1956) published some of the earliest results obtained with Dow ET-57. This compound has a very low mammalian toxicity, yet is highly toxic to parasitic arthropods. The LD 50's for several animals are as follows: rats--3,000 mg./kg.; rabbits--1,000 mg./kg.; chickens--4,000 to 5,000 mg./kg. Radeleff et al. (1957) states that LD 50 for cattle is above 400 mg./kg. The material has a very low toxicity by skin absorption. Cholinesterase is depressed in laboratory animals and cattle when Dow ET-57 is administered at therapeutic levels. The blood cholinesterase as determined by manometric methods drops about 30 to 50% but returns to normal in three to six weeks. It appears to be about as safe for young animals as for old which is unusual for a phosphate insecticide (Crenshaw, 1956).

A more extensive work on the toxicology of Dow ET-57 when administered to cattle was carried out by Radeleff (1957). When doses of 125 mg./kg. or higher were administered, it was toxic to yearling and older cattle. No symptoms were noted in any of the age groups at 100 mg./kg. except in a four-month old calf which showed a mild diarrhea. In cattle the symptoms of toxicity which were first observed at 125 mg./kg. grew progressively more severe as dosage was increased to 400 mg./kg. One cow did not return to normal until 100 days following a treatment of 400 mg./kg. Sheep receiving up to 100 mg./kg. exhibited no symptoms of toxicity. One sheep which was dosed with 400 mg./kg. showed a mild diarrhea, but no deaths resulted from any of the dosages used.

Raun (1957) worked with 77 head of cattle treated with 100 mg./kg. of Dow ET-57 in gelatin capsules. They all showed depression and inappetence within 6 hours after treatment and did not resume full feed

intake for 24 to 35 hours. Three animals showed extreme weakness, depression, and apparent loss of weight but returned to normal feeding after three days. Confirming results were also obtained by DeFoliart (1957) who dosed with 110 mg./kg. Dow ET-57 given orally. Mild transitory symptoms of poisoning were noted in 5 of 25 calves treated, but they returned to normal in 48 hours. The more toxic symptoms were noted on one-fourth of the calves on a fattening ration. Diarrhea was apparent in each of these calves, but there were no deviations in feed intake, nor were they considered seriously affected.

Radeleff (1957) described the symptoms of toxicity of Dow ET-57 as being similar at first to those of chlorinated phenols, then of organic phosphorus insecticides. There were symptoms of muscular weakness, incoordination, prostration, diarrhea, occasional salivation, and dyspnea, the whole accompanied by severe weight loss at the higher dosages. Cholinesterase was depressed progressively over a period of six to eight weeks. Recovery proceeded at the rate of 1% per day. Taylor (1957) found in a toxicity study of Dow ET-57 given at the rate of 150 mg./kg. to four steers, that rumen pH's taken before and after treatment were identical, and the cholinesterase level was little affected by the treatment. No symptoms of toxicity were noted.

The preliminary work by Crenshaw (1956) has shown Dow ET-57 to have systemic insecticidal activities when administered at 150 mg./kg. McGregor (1957) found it was also effective against screw-worms in guinea pigs at 100 mg./kg. Work by the former showed that a dosage of 100 mg./kg. fed to dogs produced mortality of fleas, lice, and ticks present on the host for a week to ten days. Also, sucking lice on cattle and hogs plus chicken lice and mites have been controlled with

the oral administration of Dow ET-57. A dose of 125 mg./kg. in cattle also controlled Oestertagia, Haemonchus, and the Cooperia species of internal parasites.

Dow ET-57 administered to cattle at the rate of 100 mg./kg. gave 82% control of cattle grubs on animals under two years old and 72% on older animals (Taylor, 1957). Adkins (1957) treated cattle in Alabama with Dow ET-57 as a drench or bolus at 110 mg./kg. Boluses gave 87% control while the drench gave 86% control. Taylor (1957) also showed there was no significant difference in control between the drench and bolus.

Roth (1957) working in Oregon, treated animals with Dow ET-57 orally and subcutaneously at doses ranging from 10 to 200 mg./kg. The oral administrations were boluses, and the subcutaneous injections were 10% solutions of Dow ET-57 in polyethylene glycol (Carbowax 400). Dow ET-57 was found to be effective against grubs present in the backs of the animals and to prevent encystment of new ones. The second instar grubs were killed more rapidly and efficiently than third instar grubs. In the oral administration the 100 mg./kg. was more effective than the 50 mg./kg. treatment. In limited tests with sprays a 2.5% solution killed 100% of the cattle grubs while a 1% solution killed 50% or less. McGregor (1957) also found that a 100 mg./kg. dose administered orally gave 97% control and completely prevented new encystments. DeFoliart (1957) using 110 mg./kg. of Dow ET-57 administered orally got essentially 100% control of grubs.

Jones (1957) at Kerrville, Texas, using Dow ET-57 at 110 mg./kg. administered orally reported 85% control. There were no reports of toxicity nor was there an apparent difference in weight gained between

the treated and untreated animals. In Oklahoma, Taylor (1957) found there was no significant difference in the weights of animals treated with Dow ET-57 and those untreated. Raun (1957) using 77 head of cattle treated with 110 mg./kg. of Dow ET-57 in gelatin capsules found that the treated animals gained 19 pounds more per head and at $1.52 less per 100 pounds gain than the untreated animals. There was 94.7% control of grubs in the treated animals.

The metabolism and excretion of P_{32} labeled Dow ET-57 in a lactating Hereford cow and its intake by the cattle grub, Hypoderma bovis (L.) were studied following an oral administration of 25 mg./kg. of the compound to the animal. The peak of radio activity in the blood was obtained between the first and third hours after treatment. Only low levels of radio activity per unit weight were found in the grubs removed 6 through 24 hours after treatment. Very little of the radio active material was secreted in the milk after 144 hours. The highest per cent of the P_{32} labeled Dow ET-57 metabolized by the cow was eliminated via the urine within 12 hours. A total of 66% of the total dose was accounted for in the urine. Less than 3% of the total dose was accounted for in the fecal samples (Robbins et al., 1957).

CHAPTER III

MATERIALS AND METHODS

The success of Dow ET-57 as an animal systemic insecticide for the control of the cattle grub prompted the Dow Chemical Company to introduce a new animal systemic insecticide. Two other companies, American Cyanamid and Chemagro, also are now distributing animal systemics for general experimental use.[1] To check the new products as well as to further test Dow ET-57, an extensive experiment involving the four readily available animal systemics was carried on during the fall, winter, and spring of 1957-58.

The animal systemic insecticides used in this study are as follows: (1) Dow ET-57 (Trolene)[2] (0,0-dimethyl 0-2,4,5-trichlorophenyl phosphorothioate) is a white crystalline compound having a molecular weight of 321.56 and a melting point of 41.0° C., is highly soluble in acetone, carbon tetrachloride, toluene, xylene, and chloroform, and is only soluble to the extent of .0044 grams in 100 grams of water. (2) Dowco 109 (O-[4-tert.butyl-2-chlorophenyl]O-methyl methyl phosphoramidothioate) is infinitely soluble in acetone, benzene, carbon tetrachloride, ethyl ether, n-heptane, methanol, corn oil, cottonseed oil, and xylene and

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[1]This is not meant to imply that other companies are not producing animal systemics for experimental use.

[2]Also sold as ET-57 Systemic Grub Killer Bolus, O. M. Franklin; Purina Grub Bolus; and Moorman's Cattle Grub Treatment.

soluble in mineral oil to the extent of 22.65 gm./100 gm. solvent; in water to the extent of 0.036 gm./100 gm. solvent. (3) American Cyanamid 12-880 (Dimethoate) (0,0-dimethyl S-0-mercapto-N-methylacetamidodithiophosphate). (4) A Chemagro compound, Bayer 21-199 (Koral) (0,0-diethyl 0-/3-chloro-4-methyl-7-coumarinyl/phosphorothioate).

There are many different types of livestock producing operations in the United States. They vary from the huge ranches of the midwestern regions of the United States where the production of beef animals is the most profitable type of operation, to the dairy farms of the northern states where large numbers of cattle are kept on relatively small farms. The small diversified farms where some dairy and some beef cattle are kept are another type of livestock producing operation. The avenue of approach for the control of cattle grubs will vary with each type of livestock operation. Several methods of application were employed in this experiment in order to find the methods of administration best suited to each type of livestock producing operation.

The boluses could possibly be used to best advantage where the cattle are located conveniently close to a corral with a head-chute or squeeze-chute. Spraying the systemic on the cattle could be very convenient for the producer with a large ranch who wishes to treat his herd and has only a holding corral in which to treat his animals. This should be especially advantageous if some of the cows are heavy with calf since there would be less chance of the cows aborting as a result of rough handling. The administration of the systemics in the daily feed of cattle would be a very practical method of grub control for the feedlot producer if the most effective rate of dosage and length of treatment could be determined.

In this experiment the systemics were administered as boluses, feed additives, and sprays. Table I shows the different systemics used, dosages, methods of applications, and the location where the experiments were performed.

A standard equine balling gun was used for administering the systemics as a bolus. A 50 gallon capacity, 4 gallon per minute, portable power sprayer was operated at a pressure of approximately 225 pounds per square inch to apply the spray formulation. The insecticides were applied as either a top line or a complete cover spray. The systemic as a feed additive was mixed with part of the cattle's daily ration.

Treatment at Coalgate, Oklahoma

Thirty-nine weaning calves were treated November 11, 1957, at the Coalgate Substation of the Oklahoma Agricultural Experiment Station. Nine head received no treatment and served as controls. Ten head received American Cyanamid 12-880 boluses,[3] 10 head received Dow ET-57 boluses, and 10 head received Dowco 109 boluses.

Treatment at Woodward, Oklahoma

The grub control tests at Woodward were superimposed on grazing tests that were being conducted on the Southern Great Plains Field Station. Seventy head of short yearling steers were used. They were in 10 pastures containing 7 steers each. Three steers per pasture (30 head) were left untreated and were used as controls. Two steers per

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[3]The term oblet is used rather than bolus by the American Cyanamid Company.

pasture (20 head) received American Cyanamid 12-880 as a bolus at the rate of 15 mg./kg., and the remaining steers (20 head) received Dowco 109 as a bolus at the rate of one-half of a 6.36 gram bolus per animal.

Treatment at Fort Supply, Oklahoma

The treatment at Fort Supply, the Range Unit of the Southern Great Plains Field Station, consisted of 139 head of short yearling steers and 130 head of mature cows.

The steers were in 10 pastures--eight pastures containing 7 each, one pasture containing 6, and one pasture containing 5. Twenty head were treated with boluses of Dowco 109 at the rate of one-half of a 6.36 gram bolus per steer, and 20 head received boluses of American Cyanamid 12-880 at the rate of 15 mg./kg. Twenty-seven head from these pastures served as controls along with 72 head that were kept in improved pastures.

Of the 130 head of mature cows in 10 different pastures, 40 head remained untreated and served as controls. Dowco 109 was given to 33 head at the rate of one 6.36 gram bolus per cow. Fourteen head were treated with American Cyanamid 12-880 boluses at the rate of 15 mg./kg. Dow ET-57 boluses were given to 19 head at the rate of 110 mg./kg.

Treatment at El Reno, Oklahoma

The tests at El Reno were conducted at the Fort Reno Livestock Research Station and the Federal Reformatory. There were 1,022 head of cattle at the Research Station and 27 heifers at the Reformatory. The heifers at the Reformatory were dusted with rotenone and used as a comparison for a group of heifers treated with a feed additive of Dowco 109.

The cows, bulls, steers, and heifers at the Experiment Station were divided into groups according to age and sex. Most of the cattle were on carefully controlled and well designed nutrition and breeding experiments which created an exceptionally good arrangement for the testing of the animal systemics.

A 10% mixture of Dowco 109, mixed with the daily ration of concentrates, was fed to 16 head of yearlings at the rate of 5 mg./kg. for 3 days and to 85 head of yearlings at the rate of 15 mg./kg. for 1 day. A 10% mixture of Dow ET-57, mixed with the daily ration of protein supplement, was fed to 12 head of yearlings at the rate of 2.5 mg./kg. for 50 days and to 12 head at 5 mg./kg. for 50 days. This systemic, mixed in the daily ration of concentrates, was administered to 18 head of yearlings at the rate of 5 mg./kg. for 25 days and to 16 head of yearlings at the rate of 10 mg./kg. for 12 days. Thirty head of 2 year-old steers received this systemic in their daily ration of silage at the rate of 2.5 mg./kg. for 6 days and 30 additional head at the rate of 5 mg./kg. for 3 days.

Dowco 109, 25% wettable powder and 50% wt./vol. emulsifiable concentrate was applied as a complete cover spray and a top line spray. The complete cover spray consisted of a 0.75% solution in 1 gallon of water while the top line spray was a 1.5% solution in 2 quarts of water. The wettable powder was applied to 36 head as a complete cover spray and to 32 head as a top line spray. The emulsifiable concentrate was applied to 110 head as a top line spray and to 90 head as a complete cover spray.

Dow ET-57 wettable powder was applied at the same concentrations as the Dowco 109 spray applications; 31 head were treated with a top line spray and 31 more with a complete cover spray.

Bayer 21-199, 25% wettable powder was applied as a 0.75% solution in 2 quarts of water as a top line spray to 160 head and as a 0.37% solution in 1 gallon of water as a complete cover spray to 96 head.

CHAPTER IV

RESULTS

Treatment at Coalgate, Oklahoma

Thirty-nine weaner calves were treated on November 11, 1957. Ten head receiving boluses of American Cyanamid 12-880 showed a 64, 72, and 74% reduction of grub population one, two, and three months after treatment. For the same periods Dow ET-57 boluses gave reductions of 74, 74, and 49%. In a group of 10 weaner calves treated with boluses of Dowco 109 there were reductions of 98, 97, and 97% in grub population. For the three month period covered by the experiment, calves treated with Dowco 109 averaged 87% grub free, while those treated with Dow ET-57 and American Cyanamid 12-880 averaged 43 and 57%, respectively. Control animals for this experiment averaged 18% grub free. The range of grub population per lot is shown in Table II.

At the end of the three month treatment period the calves treated with Dowco 109 had gained an average of 13 pounds, those treated with Dow ET-57 had gained an average of 4 pounds, those treated with American Cyanamid 12-880 had lost an average of 6 pounds, and the controls had lost an average of 1 pound (Table III).

Treatment at Woodward, Oklahoma

Forty yearling steers were treated November 7, 1957, and the grub population was checked approximately every 30 days for a period of four

months. Twenty steers treated with boluses of American Cyanamid 12-880 showed a reduction in grub population of 88, 80, 41, and 18% at the monthly checks, while steers receiving boluses of Dowco 109 showed reductions of 96, 96, 87, and 46%.

The animals treated with Dowco 109 averaged 73% grub free for the test, and the animals receiving American Cyanamid 12-880 averaged 46% grub free.

The range of grub population for the experiment was 0-29 on the steers treated with American Cyanamid 12-880, 0-6 on the steers treated with Dowco 109, and 0-57 on the controls (Table VI).

At the end of the four month treatment period the animals treated with American Cyanamid 12-880 had gained an average of 33 pounds, those treated with Dowco 109 had gained an average of 23 pounds, and the controls had gained an average of 26 pounds (Table IV).

Treatment at Fort Supply, Oklahoma

This test was comprised of yearling steers and cows of various ages all of which were treated November 7, 1957.

Twenty head of yearlings received Dow ET-57 boluses, 20 head received Dowco 109 boluses, and 99 head were left untreated and served as controls. The steers were checked for grubs four times at intervals of one month, beginning three weeks after treatment. The per cent reduction in grub population of the steers treated with Dow ET-57 was 94, 96, 93, and 99%, respectively, for the four months the counts were made, compared with reductions of 85, 92, 75, and 57% for the steers treated with Dowco 109.

The average per cent of steers grub free for this experiment was as follows: Dow ET-57, 77%; Dowco 109, 77%; and the controls, 38% (Table VII).

The differences in weight gained during the four month test, as indicated in Table V shows the controls gained 8 pounds more per animal than the steers treated with Dowco 109 and 2 pounds more per animal than those treated with Dow ET-57.

The second group of cattle consisted of brood cows. Grub counts made one, two, and three months after treatment showed reductions in grub population of 96, 85, and 56% for the cows treated with American Cyanamid 12-880; 98, 82, and 75% for the cows treated with Dowco 109; and 77, 92, and 91% for the cows treated with Dow ET-57.

The per cent of cows grub free during the three month test period was as follows: American Cyanamid, 69%; Dowco 109, 69%; Dow ET-57, 73%; and the controls 33% (Table VIII).

The range in grub population per lot for each of the treatments for the three month period was American Cyanamid 12-880, 0-18; Dowco 109, 0-18; Dow ET-57, 0-5; and controls, 0-33.

Treatment at El Reno, Oklahoma

The test cattle at El Reno were of various age groups, and several methods of application of insecticides were employed. For convenience in expressing the results, they will be discussed under the individual systemic and/or method of application used in the experiment.

Spray of Dow ET-57

Three groups of nine-year old cows were used in this experiment. Thirty-one head treated with a complete cover spray showed a 0 and 21%

reduction in grub population one and two months after treatment. Thirty-one head treated with a top line spray showed a 36 and 36% reduction in grub population when checked one and two months after treatment.

The per cent of cows grub free was as follows: top line treated, 62%; complete cover treated, 53%; and controls, 51% (Table IX).

Dow ET-57, 10% Feed Additive

Thirty-four head of yearling bulls and heifers were treated with a 10% feed additive of Dow ET-57 beginning December 9, 1957. Eighteen head received 5 mg./kg. for 25 days, and 16 additional head received 10 mg./kg. for 12 days. The animals treated with 5 mg./kg. showed an 80% reduction of grubs two weeks after treatment started and 92%, six weeks after treatment started. The animals receiving 10 mg./kg. for 12 days showed an 81 and 84% reduction in grub population on the same two check dates.

The animals that received 5 mg./kg. of Dow ET-57 averaged 61% grub free over the two month test period as compared to 69% on the animals receiving 10 mg./kg. The controls averaged 8% grub free (Table X).

Dow ET-57 was fed to a group of two-year old steers at the rate of 5 mg./kg. for 3 days and 2.5 mg./kg. for 6 days. It was mixed with their daily ration of silage. One, two, and three months after treatment the steers fed 5 mg./kg. for 3 days had reductions of 2, 2, and 51%, respectively, while the 30 steers fed 2.5 mg./kg. for 6 days showed reductions of 0, 0, and 28% for the same three check dates. Table XI shows the grub population, per cent grub free, and the range in grub population per lot.

A third group of yearling steers were fed two different levels of Dow ET-57, 10% feed additive in their daily ration of protein supplement. The 12 steers that were fed 2.5 mg./kg. of Dow ET-57 for 50 days showed a 53 and 76% reduction in grub population one and two months after treatment. Twelve additional head received Dow ET-57 at the rate of 5 mg./kg. for 25 days, and when grub counts were made one and two months after treatment, they showed reductions in grub population of 51 and 76%.

The 21 head of control animals averaged 18% grub free, while the animals treated for 25 days averaged 30% grub free and those treated for 50 days averaged 46% grub free. Table XII shows the range of grub population per lot.

Dowco 109, 10% Feed Additive

In the first test group 15 weaning calves were fed 5 mg./kg. of a 10% mixture of Dowco 109 in their daily ration of concentrates for 3 days, and 12 additional calves received 15 mg./kg. of the same compound for 1 day. Their treatment began November 26, 1957, and grub counts were made one and two months later. On these dates the grub population was reduced 94 and 93% in the calves receiving 5 mg./kg. and 98 and 97% in the animals receiving 15 mg./kg. of the insecticide.

The range in grub population per animal for the two month test period was 0-7 for the 5 mg./kg. treatment, 0-2 for the 15 mg./kg. treatment, and 0-36 for the untreated animals. The per cent of calves grub free for the three month period was 77% for the 5 mg./kg. treatment, 83% for the 15 mg./kg. treatment, and 23% for the 29 head of controls (Table XIV).

In the second group 60 head of yearling steers and heifers were fed 15 mg./kg. of a 10% mixture of Dowco 109 in their daily ration of concentrates. In comparison 27 animals were dusted with standard rotenone dust, and 21 were left untreated to serve as controls. The animals receiving Dowco 109 were checked for grubs one, two, and three months after treatment, and the grub populations were found to be reduced 99% at each of the three check dates. Counts taken two and six weeks after treatment on the yearlings dusted with rotenone showed the grub reduction to be 66 and 91%. The yearlings were dusted twice with rotenone, the middle of December and the middle of January.

The animals treated with Dowco 109 averaged 94% grub free at the end of three months, the animals treated with rotenone dust averaged 55% grub free at the end of six weeks, and the controls averaged 20% grub free at the end of three months. The range in grub population per treatment for the observation period was 0-2 for Dowco 109, 0-22 for rotenone, and 0-28 for the controls (Table XIII).

The third group consisted of 10 head of yearling bulls which were fed 15 mg./kg. of Dowco 109 in their daily ration of concentrates for 1 day. Two and six weeks after treatment the grub reduction was 82 and 99%, respectively (Table X).

Sprays of Dowco 109 and Bayer 21-199

Weaner Calves--Twenty-nine head of weaner calves were sprayed with a top line spray of Bayer 21-199 November 26, 1957. Twenty-nine head were left untreated to serve as controls. The calves were checked for grubs at periods of six weeks, two months, and three months after treatment. The per cent reduction for the treated animals was 72, 72, and

75%, respectively, for the check periods (Table XV). The per cent of treated animals grub free for the same period was 41, 41, and 73% compared with 14, 21, and 44% for the controls. The range in grub population for the three check periods was 0-19, 0-17, and 0-4 for the treated calves and 0-28, 0-36, and 0-10 for the controls.

Yearling Steers and Heifers--On November 22, 1957, 23 yearlings were sprayed with a top line spray of Bayer 21-199, and 21 head were left untreated and served as controls. In the treated animals the grub population was found to be reduced 76% six weeks after treatment, 67% two months after treatment, and 43% three months after treatment (Table XVI). The controls were found to be 5, 10, and 44% grub free on the same three check dates, whereas the treated animals were 30, 13, and 48% grub free. The range in grub population was 0-9, 0-16, and 0-4 for the treated animals and 0-23, 0-28, and 0-11 for the untreated animals.

The second group was treated with a top line spray on November 21, 1957. Thirty-two head were treated with a spray of Dowco 109, 50% wt./vol. emulsifiable concentrate, and grub counts were made approximately one, two, and three months after treatment showing grub reductions of 97, 98, and 79%. Thirty-two similar animals treated with Dowco 109, 25% wettable powder had 94, 97, and 98% reductions in grub population on the same three check dates. Bayer 21-199 was used to treat 32 head of yearlings and gave a grub reduction of 91, 94, and 86% for the test period (Table XVII).

The per cent of the animals grub free during the three month test period was 80% for the animals treated with Dowco 109 emulsifiable concentrate, 86% for those treated with Dowco 109, 25% wettable powder,

86% for those treated with Bayer 21-199, and 20% for the 21 head of controls.

The third group was treated November 25, 1957, with complete cover sprays of Dowco 109, 50% wt./vol. emulsifiable concentrate, Dowco 109, 25% wettable powder, and Bayer 21-199 wettable powder. The heifers were checked at approximately one, two, and three month intervals after treatment (Table XVIII). The animals treated with Dowco 109, 50% wt./vol. emulsifiable concentrate had a grub reduction of 94, 98, and 93% for the three checks, while the animals treated with Dowco 109, 25% wettable powder had reductions of 96, 99, and 100% for the test period. The heifers treated with Bayer 21-199 had an 89% reduction in grub population the first month after treatment and a 93 and 57% reduction on the next two monthly check dates.

The average per cent of cattle grub free was 87% for animals treated with Dowco 109, 50% wt./vol. emulsifiable concentrate and 94% for animals treated with Dowco 109, 25% wettable powder, while those treated with Bayer 21-199 averaged 78% for the test period. The controls were 20% grub free.

The range of grub population in the animals treated with Dowco 109 emulsifiable concentrate was 0-6; Dowco 109, 25% wettable powder, 0-3; and Bayer 21-199, 0-13. The controls ranged from 0-28 grubs per animal.

Two-year Old Cows--Thirty-two head of two-year old cows were used in this test, 18 of which were treated November 26, 1957, with a top line spray of Dowco 109, 50% wt./vol. emulsifiable concentrate and 18 of which were left untreated to serve as controls. The grub population in the treated cows was reduced 65% six weeks after treatment, 52% two months after treatment, and 79% three months after treatment. The

controls averaged 30% grub free for the test period, while the treated cows averaged 33% grub free (Table XIX).

The treated animals averaged 50% grub free for the two month period, while the controls averaged 18% grub free. The range of grubs per animal during the two month test period was 0-4 for the treated animals and 0-15 for the untreated animals.

Five-year Old Cows--On November 25, 1957, a complete cover spray of Dowco 109, 50% wt./vol. emulsifiable concentrate was used to treat 15 five-year old cows. Grub counts made one and two months after treatment showed reductions of 95 and 70% in grub population. A complete cover spray of Bayer 21-199 was used to treat 16 cows, and the two monthly grub counts after the treatment showed 81 and 70% reductions in grub population, compared with the 17 cows treated with a top line spray of Bayer 21-199 which gave 83 and 77% reductions for the same period. The grub population during the two month test period was 0-6 for the cows treated with a complete cover spray of Dowco 109, 50% wt./vol. emulsifiable concentrate, 0-7 for the cows treated with a complete cover spray of Bayer 21-199, 0-8 for the cows treated with a top line spray of the same compound, and 0-15 for the 16 cows used as controls (Table XXI).

Mature Cows--The cows in this test were treated November 20, 1957, and since many were heavy with calf, only one grub count was made six weeks after the initial treatment. The treatment and per cent reduction of the grub population were as follows: 81% reduction on 34 cows treated with a top line spray of Bayer 21-199, 75% reduction on 36 cows treated with a top line spray of Dowco 109, 50% wt./vol. emulsifiable concentrate, 69% on 33 cows treated with a complete cover spray of the

same compound, and 75% on 32 cows treated with a complete cover spray of Bayer 21-199. Table XXII shows the per cent of animals that were grub free for each treatment and the range in grubs per animal for the various treatments.

The second test was superimposed on the test herd of cows of various ages used in dwarfism studies. They were treated December 6, 1957, and grub counts were made one and two months after treatment. Lot 1 was sprayed with a top line spray of Dowco 109, 50% wt./vol. emulsifiable concentrate, and the grub population showed reductions of 93 and 98% on the two check dates. Lot 2 was treated with a top line spray of Bayer 21-199 and showed grub reductions of 88 and 99%. Lot 3 was treated with a complete cover spray of the same compound and showed reductions of 79 and 98% in grub population. Lot 4 was treated with a complete cover spray of Dowco 109, 25% wettable powder and reduced the grub population by 83%.

CHAPTER V

DISCUSSION

The cattle used in this study were all located at experiment stations. The grub control tests were superimposed on well designed and carefully controlled nutrition, genetic, and range management experiments. The personnel in charge of the various research projects were all highly trained in the care of livestock; many were college graduates having degrees in animal husbandry. The men in many instances were in constant contact with the cattle and in practically all cases the cattle were observed daily. Prior to treatment the herdsmen and feeders were informed of the symptoms of organic phosphorus insecticide poisoning and were asked to note any such symptoms that appeared in the cattle.

The cattle were being fed a wide variety of rations, ranging from strict maintenance to high energy fattening rations. At the time of treatment the cattle varied greatly in their state of nutrition. Some of the animals were in a very low state of nutrition while others, drylot animals, were in good flesh. The temperatures on the dates the animals were treated with sprays or boluses were never below 40° F., but the temperatures fluctuated greatly during the low level feed additive tests.

There were no symptoms of toxicity reported in any of these treated animals nor in a cooperative project involving approximately 600 head in a private herd. Since such variables as age, diet, state of nutrition,

shelter, sex, systemic, and method of application were all included in the experiment, it is evident that the experimental chemicals are nontoxic under the conditions of these experiments.

If the cattle producer could use one of the three types of treatment; i.e., spray, bolus, or feed additive, the one selected should be the most economical and practical. In determining which treatment is most economical, the actual quantity and cost per unit of the insecticide used and the labor charge must be considered.

When treating animals weighing less than 600 pounds with Dowco 109, the quantity of actual insecticide required to treat with boluses and feed additives varies less than 1 gram. It would take approximately six times as much insecticide to spray the animals as to treat them with boluses or feed additives. For treating animals weighing from 600 to 900 pounds the feed additive is most economical, quantity-wise; whereas for animals weighing over 900 pounds the bolus is the most economical. In all cases the spray treatment takes at least $2\frac{1}{2}$ times as much actual insecticide as the other two methods of treatment.

The cost of labor and the time required to treat the animals are also factors to consider when selecting the insecticide. If the animals to be treated are feedlot animals, the prescribed dosage of feed additive could be added to their daily feed with a minimum of time and effort. In treating range animals where the type of ration makes it impractical to use a feed additive, a spray would be the best treatment. It would be a rapid method of application, and labor costs would be nominal. The bolus treatment has several disadvantages--it is very slow and laborious, often excites the animal which may result in injury, or the bolus may be accidentally pushed down the windpipe. Treating with

boluses would still be very practical for the small producer who had only a few animals to treat, since he could buy a minimum of insecticide and treat his own cattle without expensive equipment.

If a livestock producer decides a spray application is the best method of treating his animals, there are several variables that should be considered before deciding whether to use a top line or complete cover spray. The complete cover application would be best if the spray was going to be a combination of compatible chemicals for the control of both the chewing and sucking louse and the cattle grub. When treating for cattle grubs only, it would be much easier to spray the top line rather than the entire animal. It is estimated that six times as many cattle can be treated with a top line spray as with a complete cover spray in a given period of time. It is more convenient to stand on the fence of the holding pen to spray the top line than it is to get into the pen with the animals in order to apply the complete cover spray.

The cattle sprayed with the systemics were treated with 2 quarts of solution for the top line spray and 4 quarts for the complete cover spray. The weight of the cows treated ranged from approximately 700 pounds to 1,450 pounds depending upon the type of experiment in which they were being used. The experimental data indicate that the differences in controls of grubs cannot be correlated with the weight of the animals.

There was an apparent difference in grub control between the animals with long and short hair coats, with the better control being on the animals with short hair. This fact implies that on animals with long, heavy hair a pressure greater than 225 p.s.i. should be used to get better penetration since the spray has to reach the skin to be fully

effective. The pressure in the spray treatment in this experiment was kept at 225 p.s.i. to insure uniform treatments and to see in what situations a higher pressure would be desirable.

The feasibility of using the same quantity of insecticide in 2 quarts of water applied as a top line spray or in 4 quarts of water applied as a complete cover spray was determined from this experiment. It was found that the treatments are equally effective if the systemic is driven through the hair to the skin.

At Coalgate, Oklahoma, the treated animals showed a marked reduction in grub population compared with the control animals. Boluses of Dowco 109 gave the best control, followed by boluses of Dow ET-57 and American Cyanamid 12-880 which were about equal in their grub controlling ability. The difference in control between the three systemics is highly significant, indicating that Dowco 109 was very effective against all instars of the grub. There appeared to be no significant differences in weight gained by the different groups of test animals (Table III).

The yearlings treated with boluses at Woodward and Fort Supply, Oklahoma, showed a marked reduction in grub population. A statistical analysis of variance showed a high degree of significance between the ability of the three systemics to control cattle grubs during the first three months of the test and a significant difference at the 10 to 30% level the last month of the test. The multiple range test showed Dowco 109 to be the best, followed closely by Dow ET-57. American Cyanamid 12-880 gave the smallest reduction in grubs until the last month when the multiple range test showed no significant difference between the three chemicals. This equality resulted from the very low population on the last check date. American Cyanamid 12-880 gave good control

the first month after treatment, but the second and third months 7 of 20 treated animals had grub populations ranging from 7 to 29 per animal (Table VI). These data support the general theory that for some systemics to be effective there must be large amounts of fat stored in the larvae; therefore, the instars that were storing large quantities of fat prior to emergence from the animal and pupation were killed, while the earlier instars were little affected by the treatment. Due to the large variations in weight noted between individual animals in test groups, the small weight variations found between test groups are considered statistically insignificant (Table IV and V).

At Fort Supply, Oklahoma, mature cows were treated with boluses of Dowco 109, Dow ET-57, and American Cyanamid 12-880 (Table VIII). A statistical analysis of variance was run on the data obtained from the monthly grub counts. There was no significant difference between the ability of the three chemicals to control cattle grubs. The multiple range test at the 5% level further substantiated this.

At Fort Reno, Oklahoma, three different systemics and several methods of application and formulation were used. The data will be discussed under the different systemics and the methods of application.

Dow ET-57 and Dowco 109, 10% Feed Additive

The addition of a 10% mixture of Dowco 109 in the daily ration of 99 head of weaner and yearling calves at the rate of 5 mg./kg. for 3 days or 15 mg./kg. for 1 day gave exceptionally good control of the cattle grub (Tables X, XII, and XIV). In this test the 1 day treatment gave slightly better control than the 3 day treatment which could mean that a higher level of the systemic in the animal at one time is more

effective than a lower level maintained over a longer period of time. For feedlot cattle the feed additive would be a very practical method of grub control.

A 10% mixture of Dow ET-57 was fed in the daily silage ration of 60 head of two-year old steers. Thirty head received 2.5 mg./kg. for 6 days, and 30 additional head received 5 mg./kg. for 3 days (Table XI). The animals that received the 5 mg./kg. dosage averaged about 1.4 fewer grubs per animal during the three month test than the other group. From these data it was concluded that neither dosage was effective for grub control, the logical reason being that the systemic must reach a certain concentration in the animal before it can be lethal to the grub, and at this dosage the lethal concentration was not reached.

A 10% feed additive of Dow ET-57 was incorporated into the daily ration of cottonseed meal of 12 yearlings at the rate of 5 mg./kg. for 25 days and 12 head at the rate of 2.5 mg./kg. for 50 days (Table XII). There was essentially no difference in the grub controlling ability of the two dosages. This treatment can be compared to another group of yearlings that received Dow ET-57 in their daily concentrate ration. Eighteen head were treated with 5 mg./kg. for 25 days and 16 head with 10 mg./kg. for 12 days. The average grub control for the 5 mg./kg. treatment was 86% and for the 10 mg./kg. treatment, 88% (Table X). The average grub control was approximately 22% higher in the yearlings that received the feed additive in their daily ration of concentrates than in the group of yearlings that had the systemic incorporated into their daily ration of protein supplement. There may be a correlation between the type of ration the systemic is incorporated into and the per cent grub control. Another factor to consider is that the 10% feed additive

was added daily to the concentrate rations, whereas it was mixed with the protein supplement in 25 day lots and fed to the animals at a predetermined rate. The extensive contact of the systemic and the cottonseed meal may possibly have resulted in some decomposition. Before any definite conclusions can be made about the interaction of the feed and the systemic more data is needed.

Dow ET-57 Spray

In this test 31 head of nine-year old cows were sprayed with a top line spray of Dow ET-57, and 31 head were sprayed with a complete cover spray of the same systemic (Table IX). Both the animals treated with top line sprays and those treated with complete cover sprays received the same amount of actual insecticide, and ineffective control was obtained in both treatments. A higher concentration might give more effective control. From the economic standpoint, however, it might not be as practical to increase the dosage as to try another formulation or another systemic.

Dowco 109 and Bayer 21-199 Sprays

To obtain the statistical analysis of variance all the weaner and yearling calves listed in Tables XV through XVIII were separated into two groups, the animals treated with Bayer 21-199 and those treated with Dowco 109. For the three month test period there was a very significant difference between the grub controlling ability of the two chemicals. In the animals treated with Dowco 109 the anlaysis of variance showed no significant difference between the top line and complete cover spray in grub control. In the animals treated with Bayer 21-199 there was a

significant difference between the two treatments. The analysis of variance was run on two carefully controlled groups of animals, 32 head of which were sprayed with a top line spray of Bayer 21-199 and 32 of which were sprayed with a top line spray of Dowco 109. There was no significant difference at the 5% level, but at the 30% level Dowco 109 provided the most effective treatment.

The cows of various age groups listed in Tables XIX through XXIII were divided as to the systemic used for treatment, and a statistical analysis of variance was run on the data. The analysis indicated there was essentially no difference between the two chemicals the first month after treatment, but the second month there was a high degree of significance. In a group of five-year old cows, 16 head were treated with a complete cover spray of Bayer 21-199, and 17 head were treated with a top line spray of the same chemical. There was no significant difference in the control of grubs between the top line application and the complete cover application.

A summary of the experiment, including per cent control, systemic, formulation, treatment, dosage, and the number of cattle in each test is shown in Table XXV.

CHAPTER VI

SUMMARY

The common cattle grub, Hypoderma lineatum (De Vill.), is one of the major insect pests of the cattle industry in Oklahoma. It is especially harmful to producers of fat steers, since the steers are often "docked" at market if sold during the grub season. To determine the efficiency of four animal systemics, Dowco 109, Dow ET-57 (Trolene), Bayer 21-199 (Koral), and American Cyanamid 12-880 (Dimethoate), for the control of this pest an extensive experiment was performed using approximately 1,450 head of cattle during the fall, winter, and spring of 1957-58. The systemics were applied in three ways; i.e., boluses, top line or complete cover sprays, and feed additives fed at various levels for different periods of time.

Dowco 109 gave 96% control of cattle grubs when fed as a 10% feed additive to yearlings, 81% control when administered as a bolus to yearlings, 85% control when given as a bolus to cows, 95% control when applied as a spray to yearlings, and 77% control when administered as a spray to cows ranging from two to nine years of age.

Bayer 21-199 gave approximately 76% control of cattle grubs when applied to yearlings as a spray and 84% control when applied as a spray to older animals. The lower control obtained when this chemical was administered to the yearlings is probably due to the fact that they were predominantly range animals with a long hair coat, and the

pressure used may not have driven the insecticide through the hair to the skin.

The yearlings treated with American Cyanamid 12-880 boluses averaged only 64% grub control, while the cows averaged 79% control. It is probable that the poorer control on the yearlings was due to the large number of grubs found two and three months after treatment. This supports the generally accepted theory that late instar grubs that are storing large quantities of fat in their body prior to emerging from the animal are easily killed by the systemics, while the earlier instars, having a lower fat content in their bodies, are much harder to kill. A partial solution may be to delay the treating date. A statistical analysis of variance showed the boluses of American Cyanamid 12-880 to be as effective as Dowco 109 and Dow ET-57 boluses in controlling cattle grubs on mature animals.

Yearlings treated with boluses of Dow ET-57 showed 74% grub control and mature cows showed 87% control. The last grub count was made when the population was very low, and at that time there was little difference between the treated and control animals. This decidedly lowered the average control for the yearling group. The sprays of Dow ET-57 were ineffective as a method of grub control. The Dow ET-57, 10% feed additive was effective when fed at the rate of 5 mg./kg. for 25 days and 10 mg./kg. for 12 days in the daily ration of concentrates. Additional data needs to be obtained on this method of treatment to determine if there is any decomposition of the systemic when it is mixed daily into the rations or mixed in large amounts and allowed to remain for prolonged periods of time before it is all fed.

The systemic that should be used for grub control is the one that can be administered most conveniently and bought most economically. The data from this experiment indicated there was no significant difference in grub control between a top line and complete cover spray if the same quantity of actual insecticide was used and driven through the hair to the skin.

There were no symptoms of toxicity reported in any of the treated animals. Since such variables as age, diet, state of nutrition, shelter, sex, systemic, and method of application were all included in the experiment, it is evident that the experimental chemicals are nontoxic under the conditions of these experiments.

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APPENDIX

TABLE I

OUTLINE OF THE METHODS OF APPLICATION, SYSTEMIC, DOSAGE, LENGTH OF TREATMENT AND LOCATION OF EXPERIMENTAL CATTLE

Method of Application	Dosage	Period of Treatment	Coal-gate	Wood-ward	El Reno	Fort Supply
Bolus						
Dow ET-57	110 mg./kg.	1 d	X			X
A.C. 12-880	15 mg./kg.	1 d	X	X		X
Dowco 109	6.36 gm.[1]	1 d	X	X		X
Feed additive						
Dow ET-57	2½ mg./kg.	6 & 50 d			X	
	5 mg./kg.	3 & 25 d			X	
	10 mg./kg.	12 d			X	
Dowco 109	5 mg./kg.	3 d			X	
	15 mg./kg.	1 d			X	
Spray						
Bayer 21-199 WP[2]						
Top line	0.75% (2 qts)	1 d			X	
Complete cover	0.37% (4 qts)	1 d			X	
Dowco 109 WP or EC[3]						
Top line	1.5% (2 qts)	1 d			X	
Complete cover	0.75% (4 qts)	1 d			X	
Dow ET-57 WP						
Top line	1.5% (2 qts)	1 d			X	
Complete cover	0.75% (4 qts)	1 d			X	

[1]One-half bolus if animal weighed less than 600 pounds; whole capsule if animal weighed above 600 pounds.

[2]WP is 25% wettable powder.

[3]EC is 50% wt./vol. emulsifiable concentrate.

TABLE II

EFFECTIVENESS OF AMERICAN CYANAMID 12-880, DOW ET-57, OR DOWCO 109 WHEN APPLIED AS A BOLUS TO WEANER CALVES AT COALGATE, OKLAHOMA, NOVEMBER 11, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal				Variation in Grub Population				Per Cent of Animals Grub Free			
			11 Nov	2 Dec	3 Jan	1 Feb	11 Nov	2 Dec	3 Jan	1 Feb	11 Nov	2 Dec	3 Jan	1 Feb
1	A.C. 12-880	10	8.6	1.7	2.8	2.7	0-60	0-9	0-14	0-10	40	70	50	50
2	Dow ET-57	10	2.8	1.2	2.6	5.2	0-13	0-9	0-6	0-14	50	80	30	20
3	Dowco 109	10	3.4	0.1	0.3	0.1	0-17	0-1	0-2	0-1	40	90	80	90
4	Controls	9	1.8	4.7	10.0	10.2	0-11	0-15	0-20	0-32	78	33	11	11

TABLE III

AVERAGE WEIGHT CHANGES OF WEANING CALVES AT COALGATE, OKLAHOMA
1957-1958

Treatment	No. of Animals	Average Weight Change Per Animal			
		11 Nov	2 Dec	3 Jan	1 Feb
A.C. 12-880	10	485	4	10	-6
Dow ET-57	10	498	-8	8	4
Dowco 109	10	463	4	15	13
Controls	9	484	-15	-2	-1

TABLE IV

TOTAL AVERAGE WEIGHT GAINED BY YEARLING STEERS AT WOODWARD, OKLAHOMA
1957-1958

Treatment	No. of Animals	1 Nov	30 Nov	31 Dec	31 Jan	28 Feb
A.C. 12-880	20	499	-4	5	22	21
Dowco 109	20	465	5	10	23	23
Controls	30	563	4	9	22	26

TABLE V

TOTAL AVERAGE WEIGHT GAINED BY YEARLING STEERS AT FORT SUPPLY, OKLAHOMA
1957-1958

Treatment	No. of Animals	1 Nov	30 Nov	31 Dec	31 Jan	28 Feb
Dowco 109	20	489	13	17	20	27
Dow ET-57	20	477	10	19	20	33
Controls	27	496	16	28	28	35

TABLE VI

EFFECTIVENESS OF DOWCO 109 OR AMERICAN CYANAMID 12-880 WHEN APPLIED AS A BOLUS TO YEARLING STEERS AT THE SOUTHERN GREAT PLAINS FIELD STATION, WOODWARD, OKLAHOMA, NOVEMBER 7, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal					Variation in Grub Population					Per Cent of Animals Grub Free				
			7 Nov	30 Nov	31 Dec	31 Jan	28 Feb	7 Nov	30 Nov	31 Dec	31 Jan	28 Feb	7 Nov	30 Nov	31 Dec	31 Jan	28 Feb
51	A.C. 12-880	2	7.5	3.0	7.5	7.5	1.0	0-15	0-6	0-15	0-15	0-2	50	50	50	50	50
	Dowco 109	2	4.0	0.5	0	0	0	3-5	0-1	0-0	0-0	0-0	0	50	100	100	100
	Controls	3	12.0	18.0	6.6	12.6	1.3	0-33	0-55	0-11	0-19	0-4	33	67	33	33	66
52	A.C. 12-880	2	0.5	0.5	1.5	7.5	1.5	0-1	0-1	1-2	6-9	0-3	50	50	0	0	50
	Dowco 109	2	1.5	0	0	0	0	0-3	0-0	0-0	0-0	0-0	50	100	100	100	100
	Controls	3	5.6	7.0	5.0	2.3	4.3	1-12	0-13	0-15	0-5	0-10	0	33	67	33	33
53	A.C. 12-880	2	3.5	0	0	1.0	0	0-7	0-0	0-0	0-2	0-0	50	100	100	50	100
	Dowco 109	2	7.0	0.5	3.5	4.0	2.5	5-9	0-1	1-6	2-6	2-3	0	50	0	0	0
	Controls	3	19.0	21.5	10.0	10.0	4.0	0-33	0-24	0-16	0-22	0-12	33	33	33	33	67
54	A.C. 12-880	2	13.0	0.5	0.5	1.0	0	0-26	0-1	0-1	0-2	0-0	50	50	50	50	100
	Dowco 109	2	0	0	0	0	0	0-0	0-0	0-0	0-0	0-0	100	100	100	100	100
	Controls	3	13.3	10.0	14.3	1.0	1.0	0-40	0-23	0-29	0-2	0-2	67	33	33	50	50
55	A.C. 12-880	2	7.0	0	0	0	0	0-14	0-0	0-0	0-0	0-0	50	100	100	100	100
	Dowco 109	2	4.0	0	1.5	2.5	1.0	2-6	0-0	0-3	0-5	0-2	0	100	50	50	50
	Controls	3	14.0	6.3	19.0	7.7	0.7	0-42	0-25	2-29	3-17	0-1	67	67	0	0	33

56	A.C. 12-880	2	0.5	0	1.0	1.5	0	0-1	0-0	0-2	0-3	0-0	50	100	50	50	100
	Dowco 109	2	3.5	0	0	2.0	1.5	0-7	0-0	0-0	0-4	0-3	50	100	100	50	50
	Controls	3	32.6	28.7	29.6	12.0	1.3	12-65	17-38	12-47	2-18	0-3	0	0	0	0	33
57	A.C. 12-880	2	3.0	0.5	12.0	22.5	5.5	0-1	0-2	11-13	26-29	4-7	50	50	0	0	0
	Dowco 109	2	10.5	1.0	0	0	0	0-21	0-2	0-0	0-0	0-0	50	50	100	100	100
	Controls	3	10.0	13.0	26.7	15.3	1.3	0-25	0-26	0-51	0-26	0-4	33	33	33	33	67
58	A.C. 12-880	2	0	0	4.5	4.5	1.0	0-0	0-0	0-9	0-9	0-2	100	100	50	50	50
	Dowco 109	2	6.5	0	1.0	1.5	1.0	0-13	0-0	0-2	0-3	0-2	50	100	50	50	50
	Controls	3	1.3	5.0	18.4	7.0	1.0	0-3	1-7	7-38	2-16	0-2	33	0	0	0	50
59	A.C. 12-880	2	5.5	1.5	4.5	4.5	0	0-11	0-3	2-7	1-8	0-0	50	50	0	0	100
	Dowco 109	2	3.0	0	1.0	3.0	0.5	0-6	0-0	0-2	0-6	0-1	50	100	50	50	50
	Controls	3	11.3	8.3	15.3	9.3	0	1-18	0-14	4-26	5-15	0-0	0	33	0	0	100
60	A.C. 12-880	2	25.0	1.5	4.5	2.0	0	19-30	1-7	0-9	0-4	0-0	0	0	50	50	100
	Dowco 109	2	0	0	0	0	0	0-0	0-0	0-0	0-0	0-0	100	100	100	100	100
	Controls	3	7.0	6.3	5.5	2.6	0.7	0-21	0-18	0-8	0-5	0-2	67	33	33	33	67
AVERAGES																	
	A.C. 12-880	20	6.9	1.1	3.6	5.7	0.9	0-30	0-7	0-15	0-29	0-7	45	65	45	40	75
	Dowco 109	20	3.7	0.4	0.7	1.3	0.6	0-21	0-2	0-6	0-6	0-3	45	80	75	65	50
	Controls	102	12.5	9.3	18.0	9.7	1.6	0-65	0-55	0-57	0-43	0-12	33	34	21	14	69

TABLE VII

EFFECTIVENESS OF DOW ET-57 OR DOWCO 109 WHEN APPLIED AS A BOLUS TO YEARLING STEERS AT FORT SUPPLY, OKLAHOMA, NOVEMBER 7, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal					Variation in Grub Population					Per Cent of Animals Grub Free				
			7 Nov	30 Nov	31 Dec	29 Jan	28 Feb	7 Nov	30 Nov	31 Dec	29 Jan	28 Feb	7 Nov	30 Nov	31 Dec	29 Jan	28 Feb
23	Dow ET-57	2	6.0	0.5	0.5	0	0	0-12	0-1	0-1	0-0	0-0	50	50	50	100	100
	Dowco 109	2	1.0	0	0	0	0	0-2	0-0	0-0	0-0	0-0	50	100	100	100	100
	Controls	3	11.3	8.6	4.3	19.7	0	3-28	0-13	38-58	11-27	0-0	0	33	0	0	100
26	Dow ET-57	2	2.5	0	0	0	0	0-5	0-0	0-0	0-0	0-0	50	100	100	100	100
	Dowco 109	2	0	0.5	9.5	12.5	0	0-0	0-1	0-19	0-25	0-0	100	50	50	50	100
	Controls	3	11.0	0	2.5	19.0	0	4-18	0-0	0-53	0-34	0-0	0	100	33	33	100
28	Dow ET-57	2	0.5	0	2.5	2.5	0	0-1	0-0	0-5	0-5	0-0	50	100	50	50	100
	Dowco 109	2	0	0	1.0	3.5	2.0	0-0	0-0	0-2	1-6	0-4	100	100	50	0	50
	Controls	3	0.3	1.6	14.0	11.3	4.0	0-1	0-5	7-26	1-26	0-12	66	66	0	0	67
29	Dow ET-57	2	16.5	0	0.5	0	0.5	10-23	0-0	0-1	0-0	0-1	0	100	50	0	50
	Dow 109	2	6.5	2.5	0	0	0	6-7	0-5	0-0	0-0	0-0	0	50	100	100	100
	Controls	1	25.0	18.0	31.0	12.0	0	25	18	31	12	0	0	0	0	0	100
30	Dow ET-57	2	14.0	0.5	1.5	1.0	0	7-20	0-1	0-3	0-2	0-0	0	50	50	50	100
	Dowco 109	2	7.5	2.5	0	0	0.5	0-15	0-5	0-0	0-0	0-1	50	50	100	100	50
	Controls	3	0	3.3	16.0	14.0	2.7	0-0	0-9	0-41	0-0	0-8	100	33	33	100	67
31	Dow ET-57	2	0	0	0	0	0	0-0	0-0	0-0	0-0	0-0	100	100	100	100	100
	Dowco 109	2	0	0	0	6.5	1.5	0-0	0-0	0-0	0-13	0-3	100	100	100	50	50
	Controls	3	4.3	9.0	25.0	9.0	0.7	0-13	0-23	0-53	0-16	0-1	67	33	33	33	67

32	Dow ET-57	2	1.0	0	1.0	1.0	0	0-2	0*	1	1	0	50	100	0	0	100
	Dowco 109	2	2.5	0	0	1.0	0	0-5	0-0	0-0	0-2	0-0	50	100	100	50	100
	Controls	3	0.3	1.0	6.0	0	0	0-1	0-1	0-17	0-0	0-0	67	33	33	100	100
33	Dow ET-57	2	4.0	0	0	0	0	0-8	0-0	0-0	0-0	0-0	50	100	100	100	100
	Dowco 109	2	0.5	1.0	0	1.0	0	0-1	0-2	0-0	0-2	0-0	50	50	100	50	100
	Controls	3	5.3	3.3	22.0	7.7	1.6	2-12	0-4	6-46	0-18	0-5	0	33	0	33	67
35	Dow ET-57	2	2.0	0	1.0	2.5	0	0-4	0-0	1-1	2-3	0-0	50	100	0	0	100
	Dowco 109	2	6.0	0	1.0	0	0	0-12	0-0	1-1	0-0	0-0	50	100	0	100	100
	Controls	3	0.6	0.6	4.0	2.7	0	0-2	0-1	0-12	0-8	0-0	67	33	33	67	100
36	Dow ET-57	2	0	0	0	0	0	0-0	0-0	0-0	0-0	0-0	100	100	100	100	100
	Dowco 109	2	13.0	4.0	3.5	1.0	0	0-26	0-8	3-4	0-2	0-0	50	50	0	50	100
	Controls	3	3.0	8.0	4.0	5.3	0.7	0-9	0-23	2-6	0-12	0-2	67	67	0	33	67
AVERAGES																	
	Dow ET-57	20	4.6	0.4	0.7	0.7	0.05	0-23	0-1	0-5	0-5	0-1	50	85	63	63	95
	Dowco 109	20	3.7	1.1	1.5	2.6	0.4	0-26	0-8	0-19	0-19	0-4	60	75	70	70	85
	Controls	99	4.6	7.1	19.0	10.3	1.0	0-28	0-52	0-57	0-57	0-12	62	39	18	18	76

*One animal of this group died.

TABLE VIII

EFFECTIVENESS OF DOW ET-57, DOWCO 109, OR AMERICAN CYANAMID 12-880 WHEN APPLIED AS A BOLUS TO COWS AT FORT SUPPLY, OKLAHOMA, NOVEMBER 7, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal				Variation in Grub Population				Per Cent of Animals Grub Free			
			7 Nov	30 Nov	31 Dec	31 Jan	7 Nov	30 Nov	31 Dec	31 Jan	7 Nov	30 Nov	31 Dec	31 Jan
17	Dowco 109	4	0.3	0	1.7	2.0	0-5	0-0	0-5	0-5	67	100	67	50
	Dow ET-57	2	2.0	1.0	0	0	2-2	0-2	0-0	0-0	0	50	100	100
	Controls	3	1.0	0	16.0	12.2	0-2	0-0	6-33	3-23	33	100	0	0
18	A.C. 12-880	2	0	0	0	0	0-0	0-0	0-0	0-0	100	100	100	100
	Dowco 109	2	1.5	0	0	0	1-2	0-0	0-0	0-0	0	100	100	100
	Dow ET-57	2	0	0	0	0	0-0	0-0	0-0	0-0	100	100	100	100
	Controls	3	0	0.3	9.3	7.0	0-0	0-1	3-13	3-10	100	66	0	0
19	A.C. 12-880	2	0.5	0	0	1.0	0-1	0-0	0-0	0-2	50	100	100	50
	Dowco 109	2	0	0	0	0	0-0	0-0	0-0	0-0	100	100	100	100
	Dow ET-57	2	0	0.5	3.0	2.5	0-0	0-1	1-5	0-5	100	50	0	50
	Controls	3	0	3.0	6.3	3.0	0-0	0-9	5-8	1-5	100	33	0	0
20	A.C. 12-880	2	0	0	4.0	10.5	0-0	0-0	1-7	3-18	100	100	0	0
	Dowco 109	2	0.5	0	9.5	4.5	0-1	0-0	1-18	0-9	50	50	0	50
	Dow ET-57	2	0	0.5	0	1.0	0-0	0-1	0-0	0-2	100	50	100	50
	Controls	3	0	5.3	12.0	6.3	0-0	0-16	0-24	0-13	100	66	33	33
21	A.C. 12-880	2	0	0	0	0	0-0	0-0	0-0	0-0	100	100	100	100
	Dowco 109	2	2.0	0	0	0	1-3	0-0	0-0	0-0	0	100	100	100
	Dow ET-57	2	1.5	0.5	0.5	0	0-3	0-1	0-1	0-0	50	50	50	100
	Controls	3	0	0	5.0	3.6	0-0	0-0	3-7	2-8	100	100	0	0

24	A.C. 12-880	2	0	0.5	1.0	3.0	0-0	0-1	0-2	1-5	100	50	50	0
	Dowco 109	2	0	0	0	2.0	0-0	0-0	0-0	0-4	100	100	100	50
	Dow ET-57	2	0	0	0	0	0-0	0-0	0-0	0-0	100	100	100	100
	Controls	3	0.3	1.3	2.7	4.3	0-1	0-3	1-6	0-11	66	66	37	33
37 a&c	A.C. 12-880	2	0	0	2.0	1.0	0-0	0-0	0-4	1-1	100	100	50	0
	Dowco 109	2	0	0	2.5	3.0	0-0	0-0	0-5	2-4	100	100	50	0
	Dow ET-57	2	0	1.0	0	1.5	0-0	0-2	0-0	0-3	100	50	100	50
	Controls	4	0.5	1.7	6.5	5.3	0-2	0-5	1-9	1-11	75	50	0	0
37 b&d	A.C. 12-880	2	0	0.5	0	0.5	0-0	0-1	0-0	0-1	100	50	100	50
	Dowco 109	2	0	0	1.0	3.0	0-0	0-0	0-2	2-4	100	100	50	0
	Dow ET-57	2	0	0	1.0	1.5	0-0	0-0	0-2	0-3	100	100	50	50
	Controls	4	0	3.7	4.0	3.5	0-0	0-15	3-5	1-11	100	75	0	0
38	Dowco 109	12	1.5	0	0.5	0.3	0-11	0-0	0-2	0-3	50	100	33	83
	Controls	12	3.2	1.4	6.3	4.9	0-15	0-6	0-26	0-14	25	58	17	17
Salt Meal	Dowco 109	4	1.0	0.3	0.8	2.5	1-2	0-1	0-3	0-5	25	75	75	25
	Dow ET-57	2	1.0	0	0	0	0-2	0-0	0-0	0-0	50	100	100	100
	Controls	2	0.5	1.0	2.0	2.5	0-1	0-2	0-2	2-3	50	50	50	0
AVERAGES														
	A.C. 12-880	14	0.07	0.07	1.0	2.4	0-1	0-1	0-7	0-18	92	92	71	43
	Dowco 109	33	0.9	0.03	1.2	1.4	0-11	0-1	0-18	0-9	54	80	62	64
	Dow ET-57	19	0.6	0.4	0.5	0.5	0-3	0-2	0-5	0-5	73	68	73	79
	Controls	40	1.2	1.7	6.6	5.5	0-15	0-16	0-33	0-23	65	67	10	23

TABLE IX

EFFECTIVENESS OF DOW ET-57 WHEN APPLIED AS A COMPLETE COVER OR TOP LINE SPRAY TO NINE-YEAR OLD COWS AT FORT RENO, OKLAHOMA, NOVEMBER 22, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal			Variation in Grub Population			Per Cent of Animals Grub Free		
			22 Nov	20 Dec	23 Jan	22 Nov	20 Dec	23 Jan	22 Nov	20 Dec	23 Jan
1	C.C. Spray	7	1.0	1.7	1.1	0-2	0-6	0-2	43	14	29
	T.L. Spray	7	0.7	0.4	1.1	0-3	0-2	0-4	71	71	57
	Controls	7	1.6	1.3	2.3	0-4	0-3	0-6	43	29	14
2	C.C. Spray	15	0.7	0.3	0.5	0-3	0-2	0-3	53	80	67
	T.L. Spray	15	0.8	0.5	0.6	0-4	0-3	0-3	67	67	60
	Controls	15	0.5	0.9	1.3	0-4	0-5	0-5	67	60	53
3	C.C. Spray	9	1.3	2.1	2.0	0-9	0-10	0-8	67	56	33
	T.L. Spray	9	0.2	1.2	1.3	0-1	0-3	0-5	78	44	44
	Controls	9	0.7	1.2	1.4	0-4	0-4	0-6	67	44	56
AVERAGES											
	C.C. Spray	31	0.9	1.1	1.1	0-9	0-10	0-8	55	58	45
	T.L. Spray	31	0.6	0.7	0.9	0-4	0-3	0-5	71	61	55
	Controls	31	0.8	1.1	1.4	0-4	0-5	0-6	61	48	45

TABLE X

EFFECTIVENESS OF DOW ET-57 OR DOWCO 109 WHEN FED TO YEARLINGS AT FORT RENO, OKLAHOMA, BEGINNING DECEMBER 9, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal		Variation in Grub Population		Per Cent of Animals Grub Free	
			23 Dec	4 Feb	23 Dec	4 Feb	23 Dec	4 Feb
1	5 mg./kg. Dow ET-57, 25 days	18	2.2	0.9	0-18	0-4	50	71
2	10 mg./kg. Dow ET-57, 12 days	16	2.0	0.7	0-10	0-8	50	87
3	15 mg./kg. Dowco 109, 1 day	10	1.9	0.1	0-8	0-1	60	90
4	Controls	21	10.8	11.3	0-23	0-28	5	10

TABLE XI

EFFECTIVENESS OF DOW ET-57 WHEN FED TO TWO-YEAR OLD STEERS
AT FORT RENO, OKLAHOMA, BEGINNING NOVEMBER 21, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal				Variation in Grub Population				Per Cent of Animals Grub Free			
			21 Nov	19 Dec	16 Jan	10 Feb	21 Nov	19 Dec	16 Jan	10 Feb	21 Nov	19 Dec	16 Jan	10 Feb
1	5 mg./kg. for 3 days	10	6.1	13.3	12.4	3.6	1-12	3-22	2-20	0-7	0	0	0	10
2	5 mg./kg. for 3 days	10	7.0	9.5	9.8	1.5	2-17	2-18	3-23	0-4	0	0	0	30
3	5 mg./kg. for 3 days	10	4.0	9.1	11.3	1.2	1-8	6-20	2-21	0-3	0	0	0	40
4	2½ mg./kg. for 6 days	10	7.4	14.4	12.1	3.9	3-13	4-23	3-24	2-5	0	0	0	0
5	2½ mg./kg. for 6 days	10	4.4	10.9	12.6	2.8	0-12	3-28	7-29	0-7	10	0	0	10
6	2½ mg./kg. for 6 days	10	3.4	11.2	14.1	2.7	0-8	5-26	5-27	0-5	20	0	0	10
AVERAGES														
	5 mg./kg. for 3 days	30	5.7	10.6	11.1	2.1	1-17	2-22	2-23	0-7	0	0	0	27
	2½ mg./kg. for 6 days	30	5.1	12.2	12.9	3.1	0-13	3-28	2-29	0-7	10	0	0	7
	Controls	21	5.3	10.8	11.3	4.3	1-15	0-23	0-28	0-11	0	5	10	44

TABLE XII

EFFECTIVENESS OF DOW ET-57 WHEN FED TO YEARLING STEERS
AT FORT RENO, OKLAHOMA, BEGINNING NOVEMBER 25, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal			Variation in Grub Population			Per Cent of Animals Grub Free		
			25 Nov	19 Dec	29 Jan	25 Nov	19 Dec	29 Jan	25 Nov	19 Dec	29 Jan
1	2½ mg./kg. for 50 days	6	4.8	8.8	4.2	0-16	0-30	0-11	17	33	33
2	2½ mg./kg. for 50 days	6	1.5	1.3	1.0	0-4	0-6	0-4	17	50	67
3	5 mg./kg. for 25 days	6	3.1	4.7	1.5	0-14	0-19	0-6	33	0	50
4	5 mg./kg. for 25 days	6	6.0	6.0	3.8	0-18	0-19	0-16	33	17	50
AVERAGES											
	2½ mg./kg. for 50 days	12	3.2	5.1	2.7	0-16	0-30	0-11	17	42	50
	5 mg./kg. for 25 days	12	4.6	5.3	2.7	0-18	0-19	0-16	33	9	50
	Controls	21	5.5	10.8	11.3	0-28	0-28	0-36	24	14	21

TABLE XIII

EFFECTIVENESS OF ROTENONE DUST OR DOWCO 109 FEED ADDITIVE IN THE CONTROL OF CATTLE GRUBS IN YEARLINGS AT FORT RENO, OKLAHOMA, NOVEMBER 22, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal				Variation in Grub Population				Per Cent of Animals Grub Free			
			22 Nov	31 Dec	28 Jan	25 Feb	22 Nov	31 Dec	28 Jan	25 Feb	22 Nov	31 Dec	28 Jan	25 Feb
1	15 mg./kg. Dowco, 1 d	60	1.3	0.1	0.1	0.01	0-15	0-2	0-1	0-1	56	92	93	98
2	Rotenone Dust*	27		3.7	1.0			0-22	0-6			45	65	
3	Controls	21	5.1	10.8	11.3	1.4	1-15	0-23	0-28	0-11	0	5	10	44

*These cattle were dusted twice at approximately one month intervals beginning the middle of December.

TABLE XIV

EFFECTIVENESS OF DOWCO 109 WHEN FED TO WEANER CALVES
AT FORT RENO, OKLAHOMA, BEGINNING NOVEMBER 26, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal		Variation in Grub Population		Per Cent of Animals Grub Free	
			2 Jan	29 Jan	2 Jan	29 Jan	2 Jan	29 Jan
1	5 mg./kg. for 3 days	15	0.6	0.8	0-7	0-7	87	67
2	15 mg./kg. for 1 day	12	0.2	0.3	0-1	0-2	83	83
3	Controls	29	10.0	11.4	0-28	0-36	14	21

TABLE XV

EFFECTIVENESS OF BAYER 21-199 WHEN APPLIED AS A TOP LINE SPRAY TO WEANER CALVES AT FORT RENO, OKLAHOMA, NOVEMBER 26, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal				Variation in Grub Population				Per Cent of Animals Grub Free			
			26 Nov	3 Jan	23 Jan	21 Feb	26 Nov	3 Jan	23 Jan	21 Feb	26 Nov	3 Jan	23 Jan	21 Feb
1	Treated	7	5.6	4.1	2.9	0.3	0-19	0-11	0-5	0-1	43	14	14	71
	Untreated	7	6.1	5.1	8.6	1.7	0-28	0-8	0-21	0-8	14	29	29	71
2	Treated	7	7.4	4.1	2.4	0.6	0-28	0-19	0-14	0-2	29	43	57	60
	Untreated	7	6.4	10.4	9.3	1.6	0-12	0-25	0-22	0-6	14	14	43	57
3	Treated	7	1.7	1.9	4.4	0.4	0-6	0-8	0-10	0-3	29	43	29	86
	Untreated	8	3.5	11.1	10.6	2.6	0-11	0-19	0-33	0-10	38	13	13	25
4	Treated	8	1.4	1.4	3.0	0.9	0-7	0-6	0-17	0-4	75	63	63	75
	Untreated	7	6.1	13.6	17.3	2.0	0-23	0-28	0-36	0-5	29	0	0	29
AVERAGES														
	Treated	29	4.0	2.8	3.2	0.5	0-28	0-19	0-17	0-4	45	41	41	73
	Untreated	29	5.5	10.0	11.4	2.0	0-28	0-28	0-36	0-10	24	14	21	44

TABLE XVI

EFFECTIVENESS OF BAYER 21-199 WHEN APPLIED AS A TOP LINE SPRAY TO YEARLING CALVES AT FORT RENO, OKLAHOMA, NOVEMBER 22, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal				Variation in Grub Population				Per Cent of Animals Grub Free			
			22 Nov	3 Jan	23 Jan	21 Feb	22 Nov	3 Jan	23 Jan	21 Feb	22 Nov	3 Jan	23 Jan	21 Feb
1	Treated	7	3.1	3.3	2.7	0.9	0-7	0-9	0-6	0-4	14	43	14	57
	Untreated	7	3.4	9.9	10.3	1.0	1-6	2-22	0-28	0-3	0	0	14	50
2	Treated	8	3.1	2.5	2.5	1.0	1-6	0-6	0-8	0-3	0	25	25	38
	Untreated	7	7.4	10.0	7.3	1.0	2-15	0-23	0-27	0-4	0	14	14	60
3	Treated	8	3.4	2.1	5.6	0.6	1-8	0-4	1-16	0-2	0	25	0	50
	Untreated	7	4.6	12.4	16.4	2.1	2-11	3-17	6-26	0-11	0	0	0	28
AVERAGES														
	Treated	23	3.2	2.6	3.7	0.8	0-8	0-9	0-16	0-4	4	30	13	48
	Untreated	21	5.3	10.8	11.3	1.4	1-15	0-23	0-28	0-11	0	5	10	44

TABLE XVII

EFFECTIVENESS OF BAYER 21-199 OR DOWCO 109 WHEN APPLIED AS A TOP LINE SPRAY TO YEARLING STEERS AND HEIFERS AT FORT RENO, OKLAHOMA, NOVEMBER 21, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal				Variation in Grub Population				Per Cent of Animals Grub Free			
			21 Nov	19 Dec	16 Jan	10 Feb	21 Nov	19 Dec	16 Jan	10 Feb	21 Nov	19 Dec	16 Jan	10 Feb
1	Dowco 109, EC	32	3.0	0.3	0.2	0.3	0-10	0-2	0-2	0-2	28	78	84	79
2	Dowco 109, WP	32	2.7	0.6	0.3	0.03	0-11	0-9	0-2	0-1	34	84	78	96
3	Bayer 21-199	32	4.9	1.0	0.7	0.2	0-26	0-11	0-4	0-2	28	63	63	88
4	Controls	21	5.1	10.8	11.3	1.4	1-15	0-23	0-28	0-11	0	5	10	44

TABLE XVIII

EFFECTIVENESS OF BAYER 21-199 OR DOWCO 109 WHEN APPLIED AS A COMPLETE COVER SPRAY TO YEARLING HEIFER CALVES AT FORT RENO, OKLAHOMA, NOVEMBER 25, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal				Variation in Grub Population				Per Cent of Animals Grub Free			
			25 Nov	19 Dec	16 Jan	25 Feb	25 Nov	19 Dec	16 Jan	25 Feb	25 Nov	19 Dec	16 Jan	25 Feb
1	Dowco 109, EC	21	4.0	0.6	0.2	0.1	0-34	0-6	0-2	0-2	29	86	86	90
2	Dowco 109, WP	21	3.3	0.4	0.1	0	0-20	0-3	0-1	0-0	25	86	95	100
3	Bayer 21-199	19	1.6	1.2	0.8	0.6	0-13	0-13	0-5	0-10	32	73	72	90
4	Controls	21	5.1	10.8	11.3	1.4	1-15	0-23	0-28	0-11	0	5	10	44

TABLE XIX

EFFECTIVENESS OF DOWCO 109 WHEN APPLIED AS A TOP LINE SPRAY TO TWO-YEAR OLD COWS AT FORT RENO, OKLAHOMA, NOVEMBER 26, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal				Variation in Grub Population				Per Cent of Animals Grub Free			
			26 Nov	3 Jan	23 Jan	21 Feb	26 Nov	3 Jan	23 Jan	21 Feb	26 Nov	3 Jan	23 Jan	21 Feb
1	Treated	7	3.1	3.3	3.7	0.3	0-8	0-11	0-17	0-1	29	14	14	71
	Untreated	7	4.9	6.1	4.0	0.9	0-14	2-10	0-9	0-5	29	0	29	71
2	Treated	6	2.8	3.0	3.3	0.5	1-4	1-7	0-7	0-1	0	0	33	50
	Untreated	5	6.0	11.4	11.4	0.4	0-11	2-39	0-33	0-2	20	0	20	80
3	Treated	5	3.2	1.2	2.6	0.6	0-8	0-4	0-9	0-1	40	60	20	40
	Untreated	6	5.5	5.7	6.3	5.8	0-12	0-14	0-15	0-15	17	17	33	17
AVERAGES														
	Treated	18	3.1	2.6	3.3	0.5	0-8	0-11	0-17	0-1	22	22	22	56
	Untreated	18	5.4	7.4	6.8	2.4	0-14	0-39	0-33	0-15	22	6	28	56

TABLE XX

EFFECTIVENESS OF DOWCO 109 WHEN APPLIED AS A COMPLETE COVER SPRAY TO THREE-YEAR OLD COWS AT FORT RENO, OKLAHOMA, NOVEMBER 26, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal			Variation in Grub Population			Per Cent of Animals Grub Free		
			26 Nov	3 Jan	23 Jan	26 Nov	3 Jan	23 Jan	26 Nov	3 Jan	23 Jan
1	Treated	6	2.3	1.7	0.8	1-3	0-3	0-2	0	17	50
	Untreated	5	8.0	6.4	4.6	5-15	2-14	2-7	0	0	0
2	Treated	4	2.0	1.3	1.5	0-3	0-3	0-4	25	50	50
	Untreated	5	6.0	5.8	6.4	0-11	2-13	2-15	20	0	0
3	Treated	6	2.0	0.3	0.7	0-4	0-1	0-2	17	67	67
	Untreated	6	3.2	1.0	2.5	0-5	0-3	0-7	17	67	50
AVERAGES											
	Treated	16	2.2	1.1	0.9	0-4	0-3	0-4	13	44	56
	Untreated	16	5.6	4.2	4.7	0-15	0-14	0-15	13	25	13

TABLE XXI

EFFECTIVENESS OF BAYER 21-199 OR DOWCO 109 WHEN APPLIED AS A SPRAY TO FIVE-YEAR OLD COWS AT FORT RENO, OKLAHOMA, NOVEMBER 25, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal			Variation in Grub Population			Per Cent of Animals Grub Free		
			25 Nov	20 Dec	28 Jan	25 Nov	20 Dec	28 Jan	25 Nov	20 Dec	28 Jan
1	C.C. Spray, Dowco 109 EC	15	0.8	0.2	1.3	0-2	0-1	0-6	40	80	33
2	C.C. Spray, Bayer 21-199	16	0.7	0.8	1.3	0-3	0-7	0-4	50	62	44
3	T.L. Spray, Bayer 21-199	17	0.9	0.7	1.0	0-2	0-8	0-5	35	77	63
4	Controls	16		4.2	4.4		0-14	0-15		25	13

TABLE XXII

EFFECTIVENESS OF BAYER 21-199 OR DOWCO 109 WHEN APPLIED AS A SPRAY TO COWS AT FORT RENO, OKLAHOMA, NOVEMBER 20, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal		Variation in Grub Population		Per Cent of Animals Grub Free	
			20 Nov	3 Jan	20 Nov	3 Jan	20 Nov	3 Jan
1	T.L. Spray, Bayer 21-199	34	1.3	0.3	0-30	0-2	77	79
2	T.L. Spray, Dowco 109 EC	36	0.5	0.4	0-6	0-5	83	83
3	C.C. Spray, Dowco 109 EC	33	0.7	0.5	0-17	0-4	85	76
4	C.C. Spray, Bayer 21-199	32	0.8	0.4	0-8	0-7	72	86
5	Controls	31	0.8	1.6	0-4	0-8	61	48

TABLE XXIII

EFFECTIVENESS OF BAYER 21-199 OR DOWCO 109 WHEN APPLIED AS SPRAYS AT FORT RENO, OKLAHOMA, DECEMBER 6, 1957

Lot No.	Treatment	No. of Animals	Avg. No. Grubs Per Animal			Variation in Grub Population			Per Cent of Animals Grub Free		
			6 Dec	2 Jan	4 Feb	6 Dec	2 Jan	4 Feb	6 Dec	2 Jan	4 Feb
1	T.L. Spray, Dowco 109 EC	19	1.2	0.3	0.1	0-5	0-2	0-1	45	83	93
2	T.L. Spray, Bayer 21-199	20	0.8	0.5	0.05	0-7	0-3	0-1	65	70	95
3	C.C. Spray, Bayer 21-199	20	0.5	0.9	0.1	0-3	0-4	0-1	75	56	88
4	C.C. Spray, Dowco 109 WP	15	1.4	0.7		0-7	0-3		35	73	
5	Controls	18		4.2	4.7		0-14	0-15		25	13

TABLE XXIV

QUANTITIES OF ACTUAL INSECTICIDE REQUIRED TO TREAT ANIMALS OF VARIOUS WEIGHTS USING DIFFERENT FORMULATIONS OF SYSTEMICS

Chemical	Formulation	Dosage	Treat. Period	Weight of Animal	Grams of Actual Insecticide
Dowco 109	6.36 gm. bolus	½ bolus	1 d.	600-	3.18
	6.36 gm. bolus	1 bolus	1 d.	600+	6.36
	10% feed additive	15 mg./kg.	1 d.	500	3.41
	10% feed additive	15 mg./kg.	1 d.	1,000	6.82
	25% wettable powder and 50% wt./vol. emulsifiable concentrate	1.5% (2 qts)	1 d.	Any weight	27.20
Dow ET-57	15 gm. bolus	110 mg./kg.	1 d.	500	25.00
	15 gm. bolus	110 mg./kg.	1 d.	1,000	50.00
	10% feed additive	25 mg./kg.	6 d.	500	34.01
	10% feed additive	25 mg./kg.	6 d.	1,000	64.02
	25% wettable powder	1.5% (2 qts)	1 d.	Any weight	27.20
Bayer 21-199	25% wettable powder	0.75% (4 qts)	1 d.	Any weight	13.60
A.C. 12-880	2.5 & 1.25 gm. bolus	15 mg./kg.	1 d.	500	3.41
	2.5 & 1.25 gm. bolus	15 mg./kg.	1 d.	1,000	6.82

TABLE XXV

SUMMARY OF ANIMAL SYSTEMIC INSECTICIDE RESEARCH, 1957-1958

Formulation	Method of Administering	Dosage	Treatment Period	No. of Cattle Treated	Per Cent Control Nov	Dec	Jan	Feb	Age of Cattle
			DOWCO 109						
6.36 gm. bolus	Bolus	½ bolus	1 d.	50	92	95	84	52	Yearlings
6.36 gm. bolus	Bolus	1 bolus	1 d.	33	98	82	75		Mature cows
10% feed additive	Low level feeding	5 mg./kg.	3 d.	15			94	93	Weaners
10% feed additive	High level feeding	15 mg./kg.	1 d.	12			98	97	Weaners
10% feed additive	High level feeding	15 mg./kg.	1 d.	70		97	99	99	Yearlings
25% wettable powder	C.C. spray	0.75% (4 qts)	1 d.	21		96	99	100	Yearlings
25% wettable powder	C.C. spray	0.75% (4 qts)	1 d.	15			83		Mixed cows
25% wettable powder	T.L. spray	1.5% (2 qts)	1 d.	32		94	97	98	Yearlings
50% wt./vol. emulsifiable concentrate	C.C. spray	0.75% (4 qts)	1 d.	21		94	98	93	Yearlings
	C.C. spray	0.75% (4 qts)	1 d.	16			74	81	Cows-3 yrs.
	C.C. spray	0.75% (4 qts)	1 d.	15		95	70		Cows-5 yrs.
	C.C. spray	0.75% (4 qts)	1 d.	33			69		Mixed cows
50% wt./vol. emulsifiable concentrate	T.L. spray	1.5% (2 qts)	1 d.	32		97	98	79	Yearlings
	T.L. spray	1.5% (2 qts)	1 d.	18		62	52	79	Cows-2 yrs.
	T.L. spray	1.5% (2 qts)	1 d.	55			81	98	Mixed cows
			AMERICAN CYANAMID 12-880						
2.5 and 1.25 gm. bolus	Bolus	15 mg./kg.	1 d.	30	79	77	51	18	Yearlings
	Bolus	15 mg./kg.	1 d.	14	96	85	56		Mixed cows

DOW ET-57

15 gm. bolus	Bolus	110 mg./kg.	1 d.	30	86	88	66	57	Yearlings
15 gm. bolus	Bolus	110 mg./kg.	1 d.	19	77	92	91		Mixed cows
10% feed additive	Low level feeding	2½ mg./kg.	50 d.	12		53	76		Yearlings
10% feed additive	Low level feeding	5 mg./kg.	25 d.	12		51	76		Yearlings
10% feed additive	Low level feeding	5 mg./kg.	25 d.	18		80		92	Yearlings
10% feed additive	Low level feeding	10 mg./kg.	12 d.	16		81		94	Yearlings
10% feed additive	Low level feeding	2½ mg./kg.	6 d.	30		0	0	28	Steers-2 yrs.
10% feed additive	Low level feeding	5 mg./kg.	3 d.	30		2	2	51	Steers-2 yrs.
25% wettable powder	C.C. spray	0.75% (4 qts)	1 d.	31		0	31		Cows-9 yrs.
25% wettable powder	T.L. spray	1.5% (2 qts)	1 d.	31		36	36		Cows-9 yrs.

BAYER 21-199

25% wettable powder	C.C. spray	0.37% (4 qts)	1 d.	19		89	93	57	Yearlings
25% wettable powder	C.C. spray	0.37% (4 qts)	1 d.	16		81	70		Cows-5 yrs.
25% wettable powder	C.C. spray	0.37% (4 qts)	1 d.	52			84	98	Mixed cows
25% wettable powder	T.L. spray	0.75% (2 qts)	1 d.	29		72	72	75	Weaners
25% wettable powder	T.L. spray	0.75% (2 qts)	1 d.	32		91	94	86	Yearlings
25% wettable powder	T.L. spray	0.75% (2 qts)	1 d.	23		76	67	43	Yearlings
25% wettable powder	T.L. spray	0.75% (2 qts)	1 d.	17		83	77		Cows-5 yrs.
25% wettable powder	T.L. spray	0.75% (2 qts)	1 d.	54		80	99		Mixed cows

VITA

William Earl Allison

Candidate for the Degree of

Master of Science

Thesis: THE CONTROL OF THE COMMON CATTLE GRUB, Hypoderma lineatum (De Villers), WITH SYSTEMIC INSECTICIDES

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