

CONTROL OF GREEN JUNE BEETLE LARVAE ATTACKING
"
PASTURES, AND RESIDUES RESULTING FROM
INSECTICIDAL TREATMENTS

by

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INTRODUCTION

Early interest concerning the control of the green June beetle, Cotinis nitida Linn., also called the fig-eater, was recorded during the middle of the nineteenth century. Since that time farmers in Virginia and other Southeastern States have been trying to find better methods for the control of this insect. The larvae of this beetle, when present in large numbers, are capable of almost completely destroying certain forage crops such as alfalfa and clover, not by direct feeding, but from the results of their search for food.

The adult, although not of prime economic importance in this region, does cause considerable economic losses. It feeds on fruits from a number of different species of plants such as grapes, peaches, raspberries, apples, pears, plums and in particular figs, hence the common name fig-eater. A definite affinity also is shown towards certain grains such as corn and sorghum.

Description of the Larvae and Injury

Immediately following emergence from the egg, after an incubation period usually lasting two weeks, the larvae become quite active in their search for food. They remain active, except for rest during the day, until entering the overwintering state deep in their burrow. A newly hatched larva measures 0.6 inch in length and 0.15 inch in width, compared to nearly 2.0 and 0.5 inches respectively in the

full-grown larva. They both have similar body proportions and color patterns. The body is whitish or cream colored with a blackish brown head, which is comparatively small and well inserted into the prothoracic segment. The posterior end is somewhat slate-colored due to the food and excrement within the alimentary canal. The legs, which are small for the size of the grub, bear numerous moderately long and spinelike hairs used to assist in throwing back the earth in the burrowing process. Spiracles are prominent on the prothorax and first eight abdominal segments, being absent on the meso- and meta-thoracic segments.

The characteristic mode of locomotion is crawling on their backs with their short and somewhat aborted legs extended into the air in a seemingly useless manner. By alternate contraction and expansion of the body segments, the larvae move rapidly forward (as much as two feet per minute) in a definite direction.

Their life cycle is simple with only one generation a year, the winter being spent as third instar larvae deep in the soil. In the spring, they move toward the surface and begin feeding during warm periods. They enter the pupal stage in late May or early June but have been as late as the latter part of June in recent years. Usually within two to three weeks, they emerge as adults. In only a few days, mating takes place and eggs are deposited in the top one to four inches of soil. The incubation period varies between 12 and 14 days, depending on temperature and moisture.

The larvae do not attack plants directly but burrow in search of dead organic matter, animal manure or similar decomposing matter. Consequently, the injury consists of uprooting and loosening of the soil around the roots by extensive larval burrowing in the upper 2 to 3 inches of the soil. The plants therefore are killed either outright or left in a weakened condition so that climatic or other adverse conditions will bring on their death.

Frequently at night, the larvae will come out of the soil completely and move about in search of food; this is especially true on warm, wet evenings. The grubs have distinct, open burrows with the surface hole varying from 0.25 to 0.75 inch in diameter. At night, dirt is thrown out at the exit of their burrows in little mounds from two to three inches in diameter and closely resembling ant hills, although the particles of earth are somewhat coarser.

Need for Developing Chemical Control Methods

Chemicals for control of this insect have been in use since the middle of the nineteenth century. Among the first materials used were kerosene emulsion, coal tar emulsion and carbon disulfide. Later Paris green and arsenate of lead, mixed with a bait, came into use. Following World War II, chlorinated hydrocarbon and organic phosphate compounds possessing high insect toxicity made their appearance.

Some assistance in control of this insect, from the biological stand-point, exists in the form of the parasitic digger wasp, Scolia

dubia Say. It has never been found capable of completely holding the insect in check but in some localities it has materially assisted in its control. The adult wasp does not emerge until the middle of August, giving the beetle larvae a possible six to eight weeks of feeding before being parasitized by the wasp.

A cultural control method has been advocated but is not followed to the extent prescribed. This method involves decreasing the amount of organic matter, in the form of animal manure, placed on cultivated fields, pastures and lawns. Consequently, choice egg-laying sites are eliminated, thereby reducing the number of burrowing larvae. This also is not a complete control but does aid in decreasing the intensity of subsequent infestations.

Of the three control methods listed, i.e. chemical, biological, and cultural, greater efficiency and reliability is derived from the chemical control method.

The purpose of the first part of this investigation was to evaluate a number of insecticides in control of the larvae of the green June beetle at various rates, times and methods of application. Some of the insecticides were also evaluated in different formulations.

Need for Residue Data

Any chemical which is used as a poison in the control of an organism is potentially a hazard to domesticated animals and to man himself. Through the past twenty years the federal and state govern-

ments have become increasingly aware of this hazard. The Food, Drug and Cosmetic Act of 1938 and the Miller Amendment to this act, known as Public Law 518, have established definite regulations to protect the health of the public. The above laws determine the limits, expressed in parts per million, for the content of an insecticide, or an equally toxic degradation product, to be tolerated in raw agricultural products. All chemical companies are required to furnish reliable and adequate residue data to federal authorities for their approval before the insecticides are marketed. It is only through research by commercial, Federal and State agencies that these data can be accumulated.

The purpose of the second part of this investigation was to determine the residual properties of the insecticide aldrin, when applied to a ladino clover-orchard grass pasture, and its accumulation in pigs following grazing on treated pastures.

REVIEW OF LITERATURE

Davis et al. (1921) and Chittenden et al. (1922) published detailed reports on the biology, ecology and taxonomy of Cotinis nitida Linn., and they included information on the application of some highly poisonous inorganic materials to lawns and turfs. No information was included, however, on the control of this insect in pastures.

Within the past ten years, a large number of synthetic organic insecticides have become available for research and have shown promise of giving effective and economical control of the green June beetle. It was not until 1951, however, that research was initiated with these materials for control of this insect on ladino clover-orchard grass pastures.

Howe et al. (1953) reported that aldrin, dieldrin and heptachlor, each at the rate of two pounds per acre, lindane at 0.67 pound, and toxaphene at 20 pounds per acre, were highly effective against first instar larvae if applied just before the eggs hatched. These insecticides were ineffective at the same dosage when applied to control the third instar larvae.

No work has been reported in the literature concerning aldrin residues on ladino clover-orchard grass pastures, or in swine tissue, in conjunction with green June beetle larval control.

CONTROL EXPERIMENTS

Field Experiments For 1954

The 1954 control experiments were conducted on five pastures in Nansemond County, Virginia, consisting of three large-plot and two small-plot tests. All of the 1954 experiments were conducted with granulated formulations of various insecticides. The duster application tests will be discussed first, followed by the broadcast application tests.

Duster Applications:- A large plot test was conducted on the Allen Piland farm, Nansemond County, with the treatments being applied July 23, 1954. The experiment had three replications in a randomized, complete-block design. Individual plots were 18 feet by 100 feet. A twelve-nozzle, tractor-mounted, power duster was utilized in making the applications. The pasture had a four inch growth with no visible damage due to larval workings at the time of treatment. The results were determined by making counts of the larvae present in each plot on September 2 and 3. These counts were made in the following manner: an area containing five square feet in each plot was drenched with five gallons of a parathion solution, which was prepared by the addition of one liter of a 25 percent parathion emulsion to 150 gallons of water. One hour after applying the emulsion, the larvae on the surface of the ground within the enclosed space were counted. Table 1 lists the treatments and results from this test.

Table 1. Control of green June beetle larvae in ladino clover-orchard grass pastures following application of granulated insecticide formulations. Allen Piland farm, Holland, Virginia, 1954.

<u>Toxicant</u>	<u>Dosage</u> <u>Lbs/A</u>	<u>Formulation</u>	<u>Grubs per</u> <u>Sq. Foot</u>	<u>%</u> <u>Percent</u> <u>Control</u>
Aldrin	2.3	5% on 30/60 RVM clay <u>1/</u>	0.0	100.0
	1.9	30/40 RVM clay	0.0	100.0
	1.5	15/30 RVM clay	0.0	100.0
	1.6	30/40 LVM clay <u>2/</u>	0.0	100.0
	1.8	30/60 tobacco	0.0	100.0
	2.3	15/30	0.0	100.0
Dieldrin	2.0	5% on 30/60 RVM clay	0.0	100.0
	2.4	30/40 RVM clay	0.0	100.0
	1.4	15/30 RVM clay	0.03	99.7
	2.0	30/40 LVM clay	0.0	100.0
	2.2	30/60 tobacco	0.07	99.3
	2.0	15/30 tobacco	0.0	100.0
Heptachlor	1.7	5% on 30/60 RVM clay	0.0	100.0
	1.6	30/40 RVM clay	0.0	100.0
	1.5	15/30 RVM clay	0.23	97.6
	1.6	30/40 LVM clay	0.0	100.0
	2.0	30/60 tobacco	0.1	98.9
Toxaphene	10.5	20% on 30/40 RVM clay	0.0	100.0
	8.4	15/30 RVM clay	0.0	100.0
	10.0	30/60 tobacco	0.0	100.0
	11.3	15/30 tobacco	0.0	100.0
Chlordane	3.6	5% on 30/40 RVM clay	0.0	100.0
	2.8	30/60 tobacco	0.0	100.0
DDT	4.8	5% on 30/40 RVM clay	0.03	99.7
	4.6	30/60 tobacco	0.0	100.0
Endrin	1.8	2% on 30/60 tobacco	0.0	100.0
Isodrin	1.4	30/60 tobacco	0.0	100.0
Lindane	0.4	30/60 tobacco	0.0	100.0
Parathion	2.2	30/60 tobacco	0.0	100.0
Malathion	3.0	10% on 30/40 RVM clay	1.4	85.3
	3.0	30/40 LVM clay	4.4	53.7
	4.4	30/60 tobacco	3.87	59.3
Untreated checks			9.5	-----

1/ RVM designates soft clay granules
2/ LVM designates hard clay granules

On August 4, 1954 a small plot test was placed on the Wilkerson Holland farm, Nansemond County. The experiment consisted of four replications in a split-split plot design, with the individual plots 9 feet by 30 feet. A rotary hand duster was utilized in applying 5 percent granulated formulations of aldrin, dieldrin and heptachlor. Application was delayed until the appearance of third-instar larvae. Two days after application, 95 percent of the larvae were in the second instar and 2.5 percent in the third instar. Larval activity was evident at the time of application. On September 16 and 17, larval counts were obtained by excavation. A randomly selected, two-square-foot area in each plot was marked off, the forage was removed and the soil excavated, to a depth of six inches, was sifted to locate all larvae within the sampled area. Table 2 lists the treatments and results.

A second small plot test was placed on the Wilkerson Holland farm and was treated on August 6, 1954. The experiment consisted of four replications in a randomized, complete-block design, with the individual plots 9 feet by 25 feet. A rotary hand duster was utilized in applying the granulated formulations. The pasture had a ten-inch growth and larval activity was evident at the time of application. Larval counts were obtained in each plot on September 17 and 18 by the excavation method previously described. Table 3 lists the treatments and results.

Broadcast Application:- On July 27 and 28, 1954 a large plot test

Table 2. Control of green June beetle larvae in ladino clover-orchard grass pastures following application of granulated insecticide formulations. Wilkerson Holland farm, Holland, Virginia, 1954.

Toxicant	30/60 RVM clay ^{1/}			15/30 RVM clay			30/60 tobacco			15/30 tobacco				
	Dosage Lbs/A	Sq. Ft. Cont.	Grubs per cent	Dosage Lbs/A	Sq. Ft. Cont.	Grubs per cent	Dosage Lbs/A	Sq. Ft. Cont.	Grubs per cent	Dosage Lbs/A	Sq. Ft. Cont.	Grubs per cent	Dosage Lbs/A	Sq. Ft. Cont.
Aldrin	2.5	0.0	100	2.6	0.0	100.0	2.1	0.12	99.1	2.4	0.0	100.0	2.4	0.0
	3.7	0.0	100	3.2	0.0	100.0	3.1	0.0	100.0	3.3	0.0	100.0	3.3	0.0
	5.0	0.0	100	5.0	0.0	100.0	4.8	0.0	100.0	5.0	0.0	100.0	5.0	0.0
Dieldrin	2.3	0.0	100	2.2	0.0	100.0	2.5	0.0	100.0	2.4	0.0	100.0	2.4	0.0
	3.3	0.0	100	3.1	0.0	100.0	3.1	0.0	100.0	3.2	0.0	100.0	3.2	0.0
	4.9	0.0	100	4.4	0.0	100.0	4.7	0.0	100.9	5.2	0.0	100.0	5.2	0.0
Heptachlor	2.2	0.0	100	2.2	0.0	100.0	2.6	0.0	100.0	2.3	0.25	98.2	2.3	0.25
	3.4	0.0	100	3.3	0.38	97.3	3.2	0.12	99.1	3.0	0.0	100.0	3.0	0.0
	4.4	0.0	100	4.7	0.0	100.0	4.5	0.0	100.0	5.0	0.0	100.0	5.0	0.0
Untreated			13.83											

^{1/} RVM designates soft clay granules

Table 3. Control of green June beetle larvae in ladino clover-orchard grass pastures following application of granulated insecticide formulations. Wilkerson Holland's farm, Holland, Virginia, 1954.

<u>Toxicant</u>	<u>Dosage Lbs/A</u>	<u>Formulation</u>	<u>Grubs per Sq. Foot</u>	<u>Percent Control</u>
Aldrin	1.0	5% on 30/60 RVM clay ^{2/}	0.0	100.0
	2.2	30/60 RVM clay	0.0	100.0
	2.7	10% on No. 3 Vermiculite	0.0	100.0
	1.9	5% on 30/60 tobacco	0.25	94.9 ^{1/}
	1.0	5% on 30/60 tobacco	1.0	79.5 ^{1/}
Chlordane	2.7	5% on 30/40 RVM clay	0.0	100.0
DDT	3.4	5% on 30/40 RVM clay	0.12	97.5
Dieldrin	1.0	5% on 30/60 RVM clay	0.0	100.0
	1.0	5% on 30/60 tobacco	0.0	100.0
Endrin	0.5	2% on 30/60 tobacco	0.0	100.0
Heptachlor	1.0	5% on 30/60 tobacco	0.0	100.0
	1.2	10% on No. 3 Vermiculite	0.38	92.2
	1.1	5% on 30/60 RVM clay	0.75	84.6
Isodrin	0.5	2% on 30/60 tobacco	0.0	100.0
Malathion	1.9	10% on 30/40 LVM clay ^{3/}	2.62	46.3 ^{1/}
Toxaphene	2.9	10% on 30/40 RVM clay	0.0	100.0
Untreated checks			4.88	-----

^{1/} These plots were located next to a heavily infested area adjacent to the experiment. There may have been migration into these plots shortly before obtaining the larval counts.

^{2/} RVM designates soft clay granules

^{3/} LVM designates hard clay granules

was applied to the Wilkerson Holland Farm in Nansemond County. There were four replications in a split-split plot design with individual plots being 10 feet by 100 feet. A fertilizer distributor, ten feet wide and pulled by a tractor, was utilized in making the applications. The pasture forage was eight inches high with slight larval damage evident at the time of application. All of the toxicants used were formulated as 2 percent granulated materials. When larval counts were taken, 48 and 49 days after application, the untreated areas showed extreme larval damage. These counts were obtained from single, two-square-foot samples excavated in each plot. Table 4 presents the results of this experiments.

On July 29, 1954, a large plot test was applied on the Wilkerson Holland farm, Nansemond County. Each plot was 20 feet by 200 feet and was unreplicated. The materials were applied as previously discribed. The larval counts were obtained on September 14 by excavating two samples per plot, each two square-feet in size. Table 5 presents the results of this experiment.

Field Experiments for 1955.

The control experiments in 1955 were conducted on three pastures in Nansemond County, Virginia, which had shown moderate to heavy infestation of adults during the early part of the summer. The experiments consisted of two large-plot and one small-plot

Table 4. Control of green June beetle larvae in ladino clover-orchard grass pastures following application of granulated formulations. Wilkerson Holland farm, Holland, Virginia, 1954.

Toxicant	<u>30/40 RVM clay</u> ^{1/}			<u>15/30 RVM clay</u> ^{1/}			<u>30/60 tobacco</u>			<u>15/30 tobacco</u>		
	Dosage	Grubs per cent	Dosage	Grubs per cent	Dosage	Grubs per cent	Dosage	Grubs per cent	Dosage	Grubs per cent	Dosage	Grubs per cent
	Lbs/A	Sq. Ft. Cont.	Lbs/A	Sq. Ft. Cont.	Lbs/A	Sq. Ft. Cont.	Lbs/A	Sq. Ft. Cont.	Lbs/A	Sq. Ft. Cont.	Lbs/A	Sq. Ft. Cont.
Aldrin	1.0	0.25	92.3	0.9	0.0	100.0	0.8	1.0	69.2	1.0	0.25	92.3
	1.2	0.25	92.3	1.3	0.0	100.0	1.3	0.62	80.9	1.5	0.38	88.3
	2.3	0.38 2	88.3	2.0	0.0	100.0	1.8	0.12	96.3	2.2	0.0	100.0
Dieldrin	0.8	0.0	100.0	0.8	0.0	100.0	1.0	0.0	100.0	1.0	0.12	96.3
	1.3	0.0	100.0	1.7	0.0	100.0	1.5	0.0	100.0	1.3	0.62	80.9
	2.3	0.0	100.0	2.0	0.12	96.3	1.5	0.5	84.6	2.0	0.0	100.0
Heptachlor	0.8	0.12	96.3	1.2	0.0	100.0	0.8	5.38 2	-----	1.0	1.12	65.5
	1.1	0.0	100.0	1.6	0.0	100.0	1.3	1.12	65.5	1.6	0.12	96.3
	2.5	0.75	76.9	2.1	0.12	96.3	2.0	0.0	100.0	2.0	0.0	100.0
Untreated			3.25	-----								

^{1/} RVM - soft clay granules

^{2/} These two plots bordered on a very heavily infested area adjacent to the experiment. There may have been some migration into these plots shortly before obtaining the counts.

Table 5. Control of green June beetle larvae in ladino clover-orchard grass pastures following application of granulated insecticide formulations. Wilkerson Holland's farm, Holland, Virginia, 1954.

<u>Toxicant</u>	<u>Dosage</u> <u>Lbs/A</u>	<u>Formulation</u>	<u>Grubs per</u> <u>Sq. Foot</u>	<u>Percent</u> <u>Control</u>
Dieldrin	1.2	2% on 30/40 RVM clay ^{1/}	0.0	100
	1.2	2% on 30/60 tobacco	0.0	100
Heptachlor	1.1	2% on 30/60 tobacco	0.0	100
	1.6	10% on No. 3 Vermiculite	0.0	100
	1.7	10% on No. 2 Vermiculite	0.0	100
	1.7	10% on No. 2 Vermiculite	0.0	100
	1.8	10% on No. 2 Vermiculite	0.0	100
	2.4	2% on 30/40 RVM clay	0.0	100
Aldrin	1.4	2% on 30/60 tobacco	0.25	98.3
	1.3	2% on 30/40 RVM clay	4.0	72.4 ^{2/}
<u>Untreated checks</u>			14.5	-----

^{1/} RVM designates soft clay granules

^{2/} This plot bordered on a very heavily infested portion of the field adjacent to the experiment. There may have been migration into this plot shortly before obtaining the larval count.

tests, which were applied either with a rotary hand duster or a tractor-mounted duster. The broadcast application tests for this year were lost due to the severe rainfall encountered during August and early September. All of the 1955 tests were conducted with granulated formulations of various insecticides. Emphasis was placed on determining the minimum dosage necessary for control and the comparison between clay and vermiculite granules as carriers.

A large plot test was placed on the Wilkerson Holland farm, with treatments being applied July 18, 1955. The experiment had four replications in a balanced lattice square design. Individual plots measured 16.5 feet by 100 feet. The treated area was 12.5 feet by 100 feet leaving untreated, four-foot alleyways between treated plots. An eight-nozzle, tractor-mounted, power duster was utilized in making the applications. Each nozzle was set so that it covered a strip approximately one and one-half feet wide. The pasture had a six- to ten-inch growth at the time of application; consequently vermiculite granules did not fall through to the ground as easily as the clay. The larval counts were obtained August 9, 1955 by excavating a two-square-foot area in each plot. Table 6 lists the treatments and the results.

A second large plot test was placed on the Allen Piland farm and treatments were applied August 5, 1955. There were four replications in a randomized complete-block design, with individual plots measuring 20 feet by 100 feet. The treated area was 16 feet by 100 feet, leaving

Table 6. Control of green June beetle larvae in ladino clover-orchard grass pastures following application of granulated insecticide formulations. Wilkerson Holland farm, Nansemond County, Virginia, 1955.

<u>Toxicant</u>	<u>Dosage Lbs/A</u>	<u>Formulation</u>	<u>Grubs per Sq. Foot</u>	<u>Percent Control</u>
Endrin	0.25	1% Vermiculite	0.0	100.0
	0.4	2½% Vermiculite	0.1	97.2
	0.7	2½% Vermiculite	1.0	72.1
Isodrin	0.2	1% Vermiculite	0.0	100.0
	0.4	2½% Vermiculite	0.1	97.2
	0.9	2½% Vermiculite	0.3	91.7
Toxaphene	2.0	10% Vermiculite	0.1	97.2
	3.8	10% Vermiculite	0.2	94.5
	1.0	5% Vermiculite	0.3	91.7
DDT	2.0	10% 30/40 Clay	0.0	100.0
	2.5	10% 30/40 Clay	0.3	91.7
	1.0	10% 30/40 Clay	0.8	78.0
Aldrin	0.5	2% Vermiculite	0.4	89.0
Heptachlor	0.5	2% Vermiculite	0.8	78.0
Dieldrin	0.5	2% Vermiculite	0.0	100.0
Untreated Check			3.6	-----

a four foot alleyway between treated plots. An eight-nozzle, tractor-mounted, power duster was utilized in making the applications. Each nozzle was adjusted to cover a band two feet in width. The pasture had been grazed to a low level when applications were made, permitting most of the granules to reach the soil surface easily. Larval counts were obtained by the excavation method on September 16, 1955. The treatments and results are listed in Table 7.

A small plot test was conducted on the James A. Carr farm, Nansemond County. Treatments were applied August 5, 1955, with a rotary hand duster. There were four replications in a randomized complete-block design, with individual plots measuring 12 feet by 30 feet. The pasture had been grazed fairly low at the time of treatment. Larval counts were obtained by the excavation method on September 14, 1955. The treatments and results are presented in Table 8.

Table 7. Control of green June beetle in ladino clover-orchard grass pastures following application of granulated insecticide formulations. Allen Pilland farm, Nansemond County, Virginia, 1955.

<u>Toxicant</u>	<u>Dosage Lbs/A</u>	<u>Formulation</u>	<u>Grubs per Sq. Foot</u>	<u>% Percent Control</u>
Aldrin	0.2	1% Vermiculite	1.8	48.6
	0.35	2% Vermiculite	2.6	25.7
	0.4	2% Vermiculite	3.6	0.0
	0.35	2½% on 30/40 Clay	1.6	54.0
	0.2	1% on 30/40 Clay	2.2	37.2
	0.9	2½% on 30/40 Clay	3.1	11.4
	0.4	2% Vermiculite	3.6	0.0
Heptachlor	0.6	2% Vermiculite	2.1	40.0
	0.2	1% Vermiculite	2.9	17.2
	0.4	2% Vermiculite	3.6	0.0
Toxaphene	1.5	5% Vermiculite	1.2	65.8
	1.0	5% Vermiculite	2.5	28.6
	2.4	10% Vermiculite	3.4	2.9
Untreated Check			3.5	----

Table 8. Control of green June beetle larvae in ladino clover-orchard grass pastures following application of granulated formulations. James A. Carr farm, Nansemond County, Virginia, 1955.

<u>Toxicant</u>	<u>Dosage</u> <u>Lbs/A</u>	<u>Formulation</u>	<u>Grubs per</u> <u>Sq. Foot</u>	<u>Percent</u> <u>Control</u>
Aldrin	0.8	2½% on 30/40 Clay	0.4	90.0
	0.5	2½% on 30/40 Clay	1.0	75.0
	0.2	1% on 30/40 Clay	2.5	37.5
Dieldrin	0.4	2½% on 30/40 Clay	0.0	100.0
	0.6	2½% on 30/40 Clay	0.1	97.5
	0.2	1% on 30/40 Clay	0.6	85.0
Heptachlor	0.4	2% Vermiculite	0.2	95.0
	0.8	2% Vermiculite	2.2	45.0
	0.25	1% Vermiculite	3.2	20.0
Toxaphene	1.5	5% Vermiculite	0.8	80.0
	0.8	5% Vermiculite	2.6	35.0
	2.0	5% Vermiculite	3.4	15.0
Untreated Check			4.0	----

Results of 1954 Experiments

The large plot test with treatments and results listed on table 1, showed excellent control of green June beetle larvae. The treatments were applied as near to egg-hatching time as possible, so that the toxicants could be in contact with the newly hatched larvae in their most susceptible stage. The mesh size and hardness of the particles in the carriers did not affect, in any way, the control of the larvae. Aldrin, dieldrin, heptachlor, endrin and isodrin appeared to give excellent control at 1.5 pounds per acre. Toxaphene at 8.5 pounds per acre, DDT at 4.6, lindane at 0.4, and parathion at 2.2 pounds per acre were very effective. For control of the first instar larvae, the above dosages are definitely not the minimum, as shown by the number of treatments resulting in 100 percent control. Malathion at 4.4 pounds per acre was completely ineffective, giving only 59.7 percent control.

When insecticide application was made on August 4, the treatments and results being shown in table 2, 95.0 percent of the larvae were in the second instar. The first and third instar larvae equally composed the other 5 percent. Due to the decreased susceptibility found in the older larvae, the dosage of the toxicants was consequently increased in the test. For second instar larvae, aldrin at 2.1 pounds per acre, and dieldrin or heptachlor at 2.2 pounds per acre appeared to give excellent control.

Data from table 3 point to control of early second instar larvae

with endrin and isodrin at 0.5 pound per acre. Aldrin, dieldrin and heptachlor at 1.0 pound per acre, chlordane at 2.7 pounds, toxaphene at 2.9 pounds, and DDT at 3.4 pounds per acre also provided excellent control. There was evidence of some larval migration from the surrounding untreated area into the treated plots, probably after the concentration of the toxicant reached a sublethal level. No difference was observed in the control resulting from the different carriers being used with each toxicant.

The large plot test, with treatments and results presented in table 4, was conducted for control of first and early second-instar larvae. The insecticides formulated on clay, rather than tobacco granules, appeared to give slightly better control. The different mesh sizes appeared to be of no importance in control effectiveness. The primary aim in this test was to determine the minimum dosage at which effective control of first instar larvae could be obtained. Aldrin at one pound per acre, dieldrin at 0.8 pound, and heptachlor at 1.1 pounds per acre appeared to result in effective control.

The data listed in table 5 were obtained from various formulations of dieldrin, heptachlor and aldrin applied at a time when the larvae were predominately in the first instar. The heptachlor was formulated with clay, vermiculite and tobacco, whereas aldrin and dieldrin were formulated with clay and tobacco. Again, the carrying agents apparently exerted no effect upon control efficiency. Dieldrin and heptachlor at rates as low as 1.2 and 1.1 pounds per acre, respec-

tively, gave 100 percent control. Aldrin at 1.4 pounds per acre resulted in excellent control except in one of the four replications, probably due to its proximity to a heavily infested untreated area.

Results of 1955 Experiments

The applications listed in table 6 were applied at time of egg hatching with the intent of locating the minimum dosage necessary for control. Endrin appeared to give good control at approximately 0.25 pound per acre, although at the high dosage of 0.7 pound the control was only 72.1 percent. This low percentage control is a result of one plot out of five containing a large number of larvae, which may be attributable to an error in application. Isodrin at 0.2 pound per acre and toxaphene or DDT at 2.0 pounds per acre appeared to result in very good control. Aldrin and dieldrin provided excellent control at 0.5 pound per acre. Heptachlor at 0.5 pound per acre provided fair control.

Table 7 presents the results for a large plot test in which the larval population was predominately second instar at the time of application. Low concentration of aldrin, dieldrin, heptachlor and toxaphene were employed for the purpose of establishing the minimum levels of the materials necessary for effective control of second-instar larvae. It is quite evident from the table that very poor control was obtained. This could be attributable to larval migration into the treated plots, since the intense rains prevented larval

counts being made until after the most desirable time. Also this dosage could be below the level necessary for control.

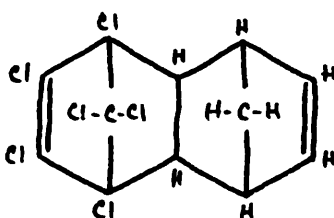
Table 8 records the treatments and results for a small plot test in which all applications were at the low dosage level and were applied for control of second instar larvae. These data are inconclusive as to the dosage necessary to control second instar larvae. The factors listed in the above paragraph could also apply to this test since both were conducted at the same time.

The combined control data from 1954 and 1955 show that aldrin and dieldrin at one pound per acre, and heptachlor at 1.2 pounds per acre, resulted in excellent control when applied to first or early second instar larvae. Aldrin and dieldrin at 0.5 pound per acre appeared to provide effective control, but this might be misleading because of a low population of grubs in the check plots. Endrin and isodrin at 0.5 pound per acre provided excellent control when applied to first or early second instar larvae. Endrin at 0.25 pound per acre and isodrin at 0.2 pound also appeared to provide effective control but, again, this may be attributable to the presence of a low population of grubs. DDT at two pounds per acre, chlordane at 2.7 pounds, and toxaphene at 2.9 pounds per acre provided excellent control of first and second-instar larvae. Duster and broadcast applications of granulated formulations appeared to result in equally effective control. Insecticides formulated on clay, vermiculite or tobacco granules were equally effective in the control obtained. The mesh size of the

granulated carriers did not appear to affect the control provided by the insecticides.

ALDRIN RESIDUE DETERMINATION

Hexachlor-hexahydro-endo, exo-dimethano-naphthalene (HHDN, or aldrin), is the bicyclo-ring organic compound depicted structurally below:



This material exhibits a high order of toxicity towards insects and possesses comparatively long residual activity.

From previous control tests, aldrin had shown promise of being an outstanding insecticide for the control of the green June beetle larvae. Because of its residual properties, an investigation was initiated in the summer of 1955 to study its persistence on ladino clover-orchard grass pastures when applied directly to the foliage. A similar investigation had been carried out during the summer of 1953 and 1954 to determine the amount of insecticide, if any, that was being stored in the tissues of swine fed on insecticide-treated pastures. All of the following tests, related to the determination of residues on pasture foliage or in swine tissues, were conducted at the Tidewater Field Station of the Virginia Agriculture Experiment Station, Holland, Virginia.

Field Test for Obtaining Residue Data.

Swine Tissue: - Preliminary tests were conducted during the summer of 1953 by Davich (unpublished) to determine the magnitude of the insecticide residue that may accumulate within the tissue of swine grazed on aldrin-treated pastures. These tests are discussed in the following paragraph.

Three ladino clover-orchard grass pastures, each approximately 50 feet by 150 feet, were treated with granulated aldrin formulations and a fourth was left untreated as a check. The applications resulted in 1.9, 7.0 and 14.8 pounds of aldrin per acre. Eight young swine, all litter mates, were classed into two weight groups. One from each group was then placed on each of the four plots four days after treatment. The animals remained on the treated pastures for 77 days, at which time they were slaughtered and certain tissues removed for aldrin analysis. Tissue from one group was analyzed by chemists of the Insecticides Investigation Section, Entomology Research Branch, U.S.D.A., Beltsville, Maryland. Tissue from the second group was analyzed by chemists of Shell Chemical Corporation, Denver, Colorado. These results are presented in table 9. Shell Chemical Corporation chemists have stated that aldrin, when ingested by swine, may be converted to dieldrin. Consequently, the swine tissue they received was analyzed for dieldrin as well as aldrin.

During the summer of 1954, additional experiments on the accumulation of toxicants within the tissues of swine were conducted at Holland, Virginia.

Table 9. Results of analysis of certain swine tissue for aldrin and dieldrin content after the swine had grazed on aldrin-treated pastures for 77 days. Holland, Virginia, 1953.

Toxicant dosage pounds/acre	Formulation	Tissue Analyzed	Toxicant found, ppm		
			Aldrin ^{1/}	Dieldrin ^{2/}	Dieldrin ^{3/}
1.9	2% on 30/60 RVM ^{4/} clay	leaf fat	1.2	----	----
		fat back	2.2	----	----
7.0	5% on 30/60 tobacco	leaf fat	1.0	----	----
		fat back	lost	----	----
14.8	5% on 30/60 RVM clay	leaf fat	5.1	----	----
		fat back	2.0	----	----

Untreated check		fat back	<0.1	0.2	0.2
		liver	<0.1		
1.9	2% on 30/60 RVM clay	fat back	<0.1	0.2	0.4
		liver	<0.1		
7.0	5% on 30/60 tobacco	fat back	<0.1	0.62	0.9
		liver	<0.1		
14.8	5% on 30/60 RVM clay	fat back	<0.1	1.82	2.7
		liver	<0.1		

^{1/} All samples above broken line were analyzed by USDA chemists using the organic chloride method. All samples below the line were analyzed by Shell Chemical Corporation chemists using the phenyl azide-photometric method which is specific for aldrin.

^{2/} Analysis based on the phenyl azide-photometric method, which is specific for dieldrin.

^{3/} Analysis based on bioassay method using horsefly larvae.

^{4/} RVM designates soft clay granules.

Eight ladino clover-orchard grass pastures, each approximately 60 feet by 120 feet, were treated with granular insecticide formulations and a ninth was left untreated as a check. Application was made with a rotary hand duster. Eighteen young swine were equally divided into two groups, one of which averaged 40 pounds per animal and the other 60 pounds per animal. On the third day following application, one animal from the 40 pound group was placed in each of the nine pastures. On the sixteenth day following application, one animal from the larger weight group was placed in each of the nine pastures. All test subjects were slaughtered December 14, 1954, at which time the first group had grazed 132 days and the second group 119 days. Fat and liver samples were taken from each animal and sent to chemists of Shell Chemical Corporation, Denver, Colorado, and chemist of the Insecticides Investigation Section, Entomology Research Branch, U.S.D.A., for analyses of insecticide content. Table 10 lists all the applications and results. The complete results of the toxaphene and heptachlor samples had not been received when this was written. Table 11 gives analyses of the swine recovery samples.

Pasture foliage:- Field work for the ladino clover-orchard grass aldrin residue determinations were conducted at Holland, Virginia, in the summer of 1955.

There were four replications in a randomized complete-block design. Individual plots were 15 feet by 40 feet, with 25-foot alleyways between replicates. A rotary hand duster was employed in making

Table 10. Analyses of swine tissue for the presence of accumulated insecticides.

<u>Toxicant</u>	<u>Dosage</u> <u>Lbs/A.</u>	<u>Formulation</u>	<u>No. of days</u> <u>on pasture</u> ^{1/}	<u>Toxicant found in p.p.m.</u> ^{2/} <u>Aldrin</u>	<u>Toxicant found in p.p.m.</u> ^{3/} <u>Dieldrin</u>	<u>Toxicant found in p.p.m.</u> ^{3/}
Aldrin	Apparent toxicant			0.08		
	2.0	5% on 30/60 clay	132	<0.1	<0.1	0.0
	2.0	5% on 30/60 clay	119	<0.1	<0.1	
	4.0	5% on 30/60 clay	132	<0.1	<0.1	0.4
	4.0	5% on 30/60 clay	119	<0.1	<0.1	0.5
Dieldrin	Apparent toxicant				0.06	
	1.7	5% on 30/60 clay	132	---	0.48	3.0
	1.7	5% on 30/60 clay	119	---	0.22	0.1
	3.9	5% on 30/60 clay	132	---	0.22	
	3.9	5% on 30/60 clay	119	---	0.25	1.1
Heptachlor	2.0	5% on 30/60 tobacco				
	3.6	5% on 30/60 tobacco	132			0.9
Toxaphene	7.0	20% on 30/40 clay				
	16.0	20% on 30/40 clay	132			1.0

Table 10. (Continued)

- 1/ All swine remaining on pastures for 132 days averaged 40 pounds each when introduced to the pasture. Those remaining for only 119 days averaged 60 pounds each.
- 2/ Determinations were made by Shell Chemical Corporation, Denver, Colorado. The analyses were based on the phenyl azide-photometric method. Samples were analyzed for dieldrin as well as aldrin since the latter is converted into dieldrin when ingested by swine.
- 3/ Determinations were conducted by the Insecticides Investigation Section, Entomology Research Branch, U.S.D.A., Beltsville, Maryland. The analyses were based on the total organic chloride method with the lower limits of sensitivity approximately 0.5 p.p.m.

Table 11. Analyses of swine tissue recovery samples at Shell Chemical Corporation, Denver, Colorado, 1955.

<u>Toxicant</u>	<u>Rate added to swine tissue</u>	<u>Percent recovery</u>
Aldrin	0.1 ppm	87
Aldrin	0.3 ppm	83
Dieldrin	0.1 ppm	80
Dieldrin	0.3 ppm	80

the applications on August 1, 1955. An early hour in the day was chosen, so that loss of dust from wind would be minimized and the heavy dew on the foliage would aid in retaining the dust. At the time of treatment, the foliage had a four- to six-inch growth. Aldrin was the only insecticide used in the treatments. It was formulated on three different carrying agents: 30/40 mesh "Attaclay" granules, number 2 vermiculite granules and 325-mesh "Attaclay" dust.

Uniform samples were taken from each plot at five different time intervals following the application of the insectide. The method for obtaining the samples consisted of cutting the pasture foliage at about one inch above the soil surface. The sampling days, with the sampled areas shown in parentheses, were: the afternoon of the day of application (20 sq. ft.), and the third (16 sq. ft.), seventh (9 sq. ft.), fourteenth (9 sq. ft.), and twenty-first (9 sq. ft.) days following application. The samples were prepared for chemical analysis by cutting the foliage into pieces approximately one inch in length. The samples were then placed in a polyethylene bag, tightly wrapped, tagged and stored immediately in a freezer until ready for chemical analysis.

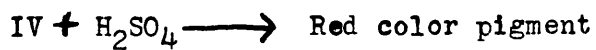
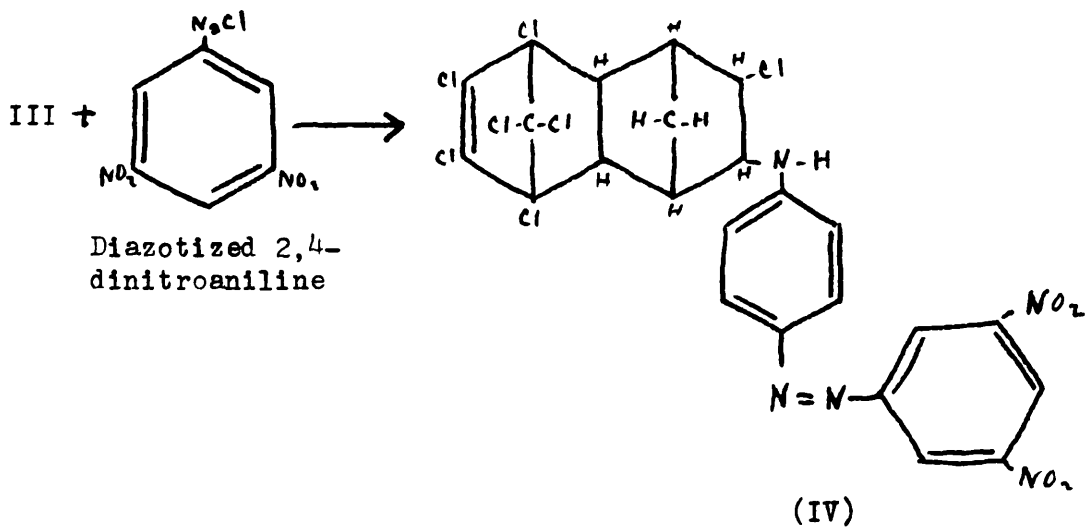
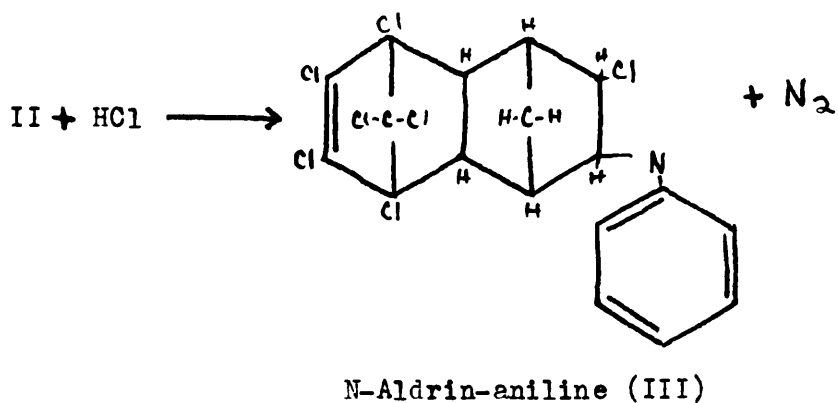
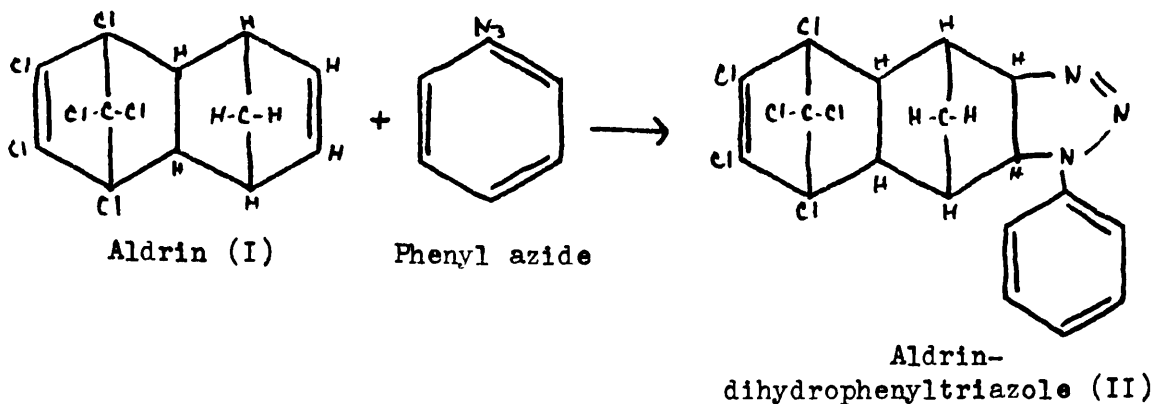
Hot, dry weather existed from the beginning of the experiment until after the third sample was taken. Rainfall totaling 6.56 inches occurred, however, before the fourth sample was taken; and an additional 2.8 inches occurred during the interval between time of taking the fourth and fifth samples. Consequently, the first three

samples should have maximum residues; whereas the others were subject to the effects of excessive rainfall.

Half of the foliage samples were chemically analyzed by the writer in a laboratory of the Virginia Agricultural Experimentation Station, Holland, Virginia. The others were analyzed by Shell Chemical Corporation, Denver, Colorado.

Description of Analytical Procedure

A number of methods for the determination of microgram quantities of aldrin have been proposed. These fall into two general categories based on their degree of specificity. Two nonspecific methods are chlorine determination and bioassay. The laboratory facilities, being limited in space and equipment, eliminated these two from further consideration. A colorimetric method proposed by Danish and Lidov (1950), and involving the reaction of aldrin with phenyl azide, was considered and later accepted. This method was of interest because of the apparent specificity of the phenyl azide reagent towards the bicycloheptene structure and because of the high sensitivity of the test. The complete chemical reactions involved in the determination are shown below:



This method, along with the "clean-up" and chromatographic procedure, is summarized in the following paragraphs.

The weighed sample was agitated in the presence of a measured volume of a purified hydrocarbon solvent, "Skellysolve B". Filtration removed the hydrocarbon extract from the sample and an aliquot of the extract was concentrated on a steam bath. Thirty grams of a clean-up absorbent mixture¹ were then added to the flask containing the extract and mixed vigorously. The supernatant liquid was filtered into a clean, dry flask and concentrated on a steam bath. The solution was then passed through an absorbent mixture² in a chromatographic column to remove all plant material. The column was washed with additional solvent and the combined effluent evaporated to concentrate the aldrin.

Phenyl azide was added to the above concentrate and the hydrocarbon solvent removed by air evaporation. The residue was then heated to 75 degrees Centigrade to form the aldrin-dihydrophenyltriazole. Excess phenyl azide was removed by distillation under vacuum. The triazole, dissolved in isopropyl alcohol, then was coupled with diazotized 2, 4-dinitroaniline in the presence of hydrochloric acid. Sulfuric acid was added to develop the color and

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1. Prepared by mixing the following materials: Nuchar, Silicic Acid, Attaclay and Activated Carbon in a ratio of 2:10:10:10 by weight.
 2. Prepared by mixing the following materials: "Attasol" and "Hyflo Supercell" in a ratio of 3:2 by weight.

the transmittance of the solution was measured at 515 mu using a colorimeter. A blank determination having been made, the difference between the transmittance of the sample and the blank was taken as a measure of the aldrin content of the sample. The amount of HHDN equivalent to the transmittance was determined by reference to a previously prepared calibration curve. The reliability of the curve was between 10 and 40 micrograms of aldrin, and the sensitivity of the analytical method was 0.1 part per million.

The aldrin contents in parts per million for the forage samples analyzed by the two laboratories stated previously are listed in table 12. Analyses of the recovery samples are given in tables 13 and 14.

Results of Swine Tissue Analyses

The 1953 experiments showed that if swine were grazed on pastures which had been heavily treated with aldrin there would be insecticidal accumulation within certain body tissues. Analyses for aldrin based on the total chloride method were considerably higher than those obtained from the specific phenyl azide method. This is to be expected since the organic chloride method measures all chlorine-containing insecticides and their chlorine-containing degradation products. On the other hand the phenyl azide method is specific for aldrin. The difference is quite apparent in table 9 with the non-

Table 12. Residues obtained in parts per million from aldrin-treated ladino clover-orchard grass samples taken periodically after treatment.

Percent Formula	Toxicant, Lbs/A. 1/	Intervals, in days, between treatment and sampling									
		0	3		7		14		21		
Vermiculite Formulations: 2/											
	A 3/	B 4/	A	B	A	B	A	B	A	B	
2.0%	0.47	0.60	0.89	0.41	0.51	0.11	0.19	<0.10	<0.10	<0.10	
5.0%	1.00	1.1	1.7	0.67	1.3	0.40	0.48	<0.10	<0.10	0.16	
5.0%	2.36	1.4	2.9	0.54	1.2	0.51	0.75	0.15	0.68	<0.10	
Clay Formulations: 5/											
2.5%	0.25	0.71	0.50	0.23	0.39	0.17	0.23	<0.10	0.13		
5.0%	0.82	0.97	0.92	0.21	0.46	0.23	0.45	<0.10	0.15		
5.0%	2.22	2.3	2.0	1.4	1.6	1.0	0.80	0.26	0.44	<0.10	
Dust Formulations: 6/											
2.5%	0.50	1.2	1.6	0.41	0.54	0.15	0.18	<0.10	<0.10		
5.0%	0.91	2.1	3.6	0.81	0.89	0.36	0.52	<0.10	<0.10		
5.0%	2.13	3.3	6.2	1.5	2.7	0.53	1.5	0.15	0.19	<0.10	<0.10

Table 12. (Continued)

- 1/ The apparent aldrin found in the untreated plots from analyses by the writer was 0.03 part per million and by Shell Chemical Corporation was 0.02 part per million.
- 2/ Formulated on No. 2 size (equivalent to 8/30-mesh) particles.
- 3/ All results presented in this column were determined by the writer at the Virginia Agriculture Experiment Station.
- 4/ All results in this column were determined by Shell Chemical Corporation.
- 5/ Formulated on 30/40-mesh "Attaclay".
- 6/ Formulated on 325-mesh "Attaclay".

Table 13. Analyses of forage recovery samples at Experiment Station, Holland, Virginia, 1955.

<u>Toxicant</u>	<u>Rate added to forage samples</u>	<u>Percent recovery</u>
Aldrin	0.1 ppm	85
Aldrin	0.3 ppm	83
Aldrin	0.5 ppm	90

Table 14. Analyses of forage recovery samples at Shell Chemical Corporation, Denver, Colorado, 1955.

<u>Toxicant</u>	<u>Rate added to forage samples</u>	<u>Percent recovery</u>
Aldrin	0.1 ppm	80
Aldrin	0.3 ppm	93

specific method recording between 1.0 and 5.1 parts per million whereas values from the specific method were all less than 0.1 part per million. The dieldrin content was surprisingly high since it was formed completely from aldrin following ingestion by the swine. The non-specific dieldrin analyses, involving bioassay with horsefly larvae, recorded slightly higher results than the specific method which was an adaption of the aldrin phenyl azide method for dieldrin.

Incomplete data were obtained in 1954 on insecticide accumulation in tissue of swine grazed on aldrin, dieldrin, heptachlor and toxaphene treated pastures for 119 and 132 days. The tissue accumulations resulting from the application of aldrin to pastures at 2.0 and 4.0 pounds per acre were less than 0.1 part per million except for 0.4 and 0.5 part per million obtained from the non-specific method. The accumulations resulting from 1.7 and 3.9 pounds of dieldrin per acre showed an increase over the aldrin accumulations at comparable rates of application. The dieldrin analyses ranged between 0.22 and 0.48 part per million for the specific method but between 0.1 and 3.0 for the non-specific method.

Results of Pasture Foliage Analyses

The results of the investigation of aldrin residues on pasture foliage show that the toxicant, when applied between 0.47 and 1.0 pound per acre, was dissipated to a level less than 0.1 part per

million by the fourteenth day following application. When the dosage of the toxicant was increased to between 2.13 and 2.36 pounds per acre, a residue of less than 0.1 part per million was reached by the twenty-first day following application.

The foliage, to which aldrin on clay and vermiculite granules were applied, showed significantly lower residues six hours after treatment than the plots treated with dust. This may be due to two factors. First, the weight and size of the granules caused them to pass through the foliage onto the soil surface leaving fewer particles in contact with the foliage. Secondly, at time of application there was a heavy dew causing the 325-mesh dust particles to adhere to the foliage surface, thereby permitting only a small portion to pass through to the ground. By the seventh day following application, very little difference was seen in the residues resulting from the different formulations.

If it had not been for the heavy rains between the seventh and fourteenth days following treatment, samples taken at the latter time might have contained higher residues.

CONCLUSIONS

Excellent control of first and early second instar larvae of the green June beetle was obtained in 1954 and 1955 with aldrin and dieldrin at a dosage of one pound per acre, endrin and isodrin at 0.5 pound per acre, heptachlor at 1.2 pounds, DDT at 2.0, chlordane at 2.7, and toxaphene at 2.9 pounds per acre.

Clay, tobacco and vermiculite granules were equally effective as carriers for all the insecticides tested. Soft (RVM) and hard (LVM) clay granules exerted no differential effect upon the control obtained. Large (15/30 mesh), medium (30/40 mesh) and small (30/60 mesh) granules were equally effective as carriers. The mode of application, whether by a duster or a fertilizer distributor, appeared to exert little effect upon the control obtained.

Based on the 1953 and 1954 determinations of insecticidal accumulations within swine tissues it appears that an accumulation of less than 0.1 part per million is obtained with a foliage application of between 1.9 and 14.8 pounds of aldrin per acre and with a grazing period between 77 and 132 days. The aldrin did appear to be converted into dieldrin upon ingestion by swine. When the grazing period upon aldrin treated pastures, at the above dosages per acre, was 77 days a dieldrin content of between 0.2 and 2.7 parts per million was observed within swine tissues. When dieldrin was applied to pastures at a rate of 1.7 and 3.9 pounds per acre the tissues of swine grazed

thereon for a maximum period of 132 days was found to contain between 0.22 and 0.48 parts per million of dieldrin.

Foliage residue determinations made in 1955 showed that aldrin was dissipated to less than 0.1 part per million fourteen days following application at rates between 0.47 and 1.0 pound per acre. When applied at 2.13 and 2.36 pounds per acre, 21 days were required for the residue to reach a level less than 0.1 part per million.

Lower initial residues of aldrin were produced by granular-type carrying agents such as clay and vermiculite than by dust. This was probably due to the greater weight and size of the granular type particles. By the seventh day, residue values at each rate of application, irrespective of formulation, were approaching equality. The final level of residues among all carriers, within each rate of application, became less than 0.1 part per million at about the same time.

SUMMARY

1. The biology and habits of the green June beetle, Cotinis nitida Linn., are summarized. The need for developing new chemical control methods and for data on residues resulting from their use are discussed.
2. Tests were conducted over a period of two years on control of the green June beetle larvae using the following insecticides: aldrin, dieldrin, heptachlor, endrin, isodrin, DDT, chlordane, and toxaphene.
3. Residue analyses were conducted by two separate laboratories on samples taken at different time intervals from an aldrin-treated ladino clover-orchard grass pasture. A good dissipation curve was established from the results obtained.
4. Experiments were conducted to determine whether or not insecticides would accumulate within certain tissues of swine and the magnitude of such accumulations. For a definite period of time swine were grazed on pastures which had been treated with aldrin, dieldrin, heptachlor and toxaphene for control of green June beetle larvae. At the end of the grazing period the swine were sacrificed and analyses made of the insecticide accumulation in the leaf fat and liver.

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LITERATURE CITED

Chittenden, F. H. and D. E. Fink. 1922. "The Green June Beetle". United States Department of Agriculture, Bulletin 891.

Danish, A. A. and R. E. Lidov. 1950. "Colormetric Determination for Small Quantities of Aldrin". Analytical Chemistry, 22: 702-706.

Davis, J. J. and Philip Luginbill. 1921. "The Green June Beetle or Fig Eater". North Carolina Agricultural Experiment Station, Bulletin 242.

Howe, W. L. and W. V. Campbell. 1953. "Control of the Green June Beetle as a Pest of Ladino Clover". Journal of Economic Entomology, 46: 766-771.

. "Spectrophotometric Determination of Aldrin Residues on or in Agricultural Crops or Materials". Shell Development Company, Agricultural Research Division. Analytical Method ARMS-C-4/53.

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