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GRANULAR INSECTICIDES *for* SPITTLEBUG CONTROL

C. R. WEAVER

OHIO AGRICULTURAL EXPERIMENT STATION - - - *WOOSTER, OHIO*

CONTENTS

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LITERATURE CITED

Weaver, C. R. and D. R. King. 1954. The Meadow Spittlebug. Ohio Agricultural Experiment Station Bulletin 741.

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INTRODUCTION

A recent development in the manufacture of insecticides has been the attaching of insecticides to inert particles of relatively coarse texture. For certain types of insects a formulation of insecticide in coarse particles has several advantages over the conventional dust or spray forms. The "granulars" will mix well with fertilizers; they flow well and drift less in the wind; they are heavy enough to penetrate the foliage cover of plants, thereby giving better insecticide placement in the crowns, leaf whorls, leaf axils or other parts of the plant that are less accessible to sprays and dusts. Penetration rather than adherence to the outer foliage makes the granular formulations useful for applications of insecticides to the soil as well as potentially reducing the residue on the aerial portion of the plant.

Several inert ingredients, such as vermiculite, tobacco stems, and various clays, have been used to formulate granular insecticides. The particle size of the inerts falls in a fairly wide range. Particles that will pass a 30 mesh screen and be held by 60 mesh have been most widely used. In the tests reported in this paper 30 to 60 mesh particles were used exclusively.

Weaver and King (1954) reported several trials with various insecticides to control the meadow spittlebug *(Philaenus leucophthalmus* (L.)). In addition they cite numerous papers dealing with the subject of chemical control of the insect. Since that report was made, the granular insecticides have been introduced. The work reported in the present paper was undertaken to determine the efficacy of granular formulations for spittlebug control.

Because judgment of the field effectiveness of any particular insecticide treatment must be made on the basis of performance under a variety of conditions, the results of several trials during a 3 year period are summarized here. The conclusions drawn are based on the entire series of trials rather than on the performance of a treatment in any one test. The various aspects to be considered, *e. g.* timing, concentration, insecticide comparisons, *etc.*, are discussed with several experiments con-

tributing to the interpretations. Therefore, the tabular data have been placed in an appendix. Details of the conduct of the experiments, *i e* the size of plots, replications, *etc.*, are also summarized briefly in the appendix.

PRELIMINARY TRIAL

In 1953 only two granular formulations were available for testing at the time of spittlebug infestation. These were toxaphene 25% on attaclay and dieldrin 4% on bentonite. Since both of these insecticides are fairly effective against the meadow spittlebug in spray formulations, they were applied in granular form as a test of effectiveness of granular formulations. Both materials were applied on April 14 before the spittlebugs hatched and on May 6 after the majority of the hatch was complete. The results are shown in Table 1. None of the granular applications were as effective as the BHC spray (standard treatment). The dieldrin was effective enough, however, that it seemed feasible to test other granular formulations more extensively. Accordingly, the trials described in the following sections were carried out in 1954 and 1955.

SPRAYS COMPARED WITH GRANULARS

In 1954 BHC as a spray was compared with BHC, lindane, and dieldrin in granular form. The results are tabulated in Table 2. The granular BHC was as effective as the spray. In 1955 a similar comparison was made with both air and ground applied granular materials compared with ground applied sprays. The results, shown in Table 11, indicate that the control with granules was equivalent to that with sprays. Data from a third test are presented in Table 6. Granules and sprays of both BHC and endrin were applied, with the granules giving results equivalent to the sprays with the one exception in the late application of endrin. In this test it is not known whether the endrin formulation was losing its insecticidal property because of physical and chemical breakdown or whether late application was responsible for the inferior results.

"HOMEMADE" COMPARED WITH COMMERCIAL FORMULATIONS

In 1955 most of the formulations used in the tests were made up by spraying proprietary emulsifiable formulations of the insecticides into the clay while the latter was being rotated in a cement mixer. Since the efficacy of this procedure was unknown, the "homemade" formulations

were compared with commercial formulations of similar insecticide content. Results of this trial are shown in Table 8. Apparently the "homemade" preparations were as effective as the commercially prepared material.

INSECTICIDE COMPARISONS

Tables 1 to 7, and 9 and 10 present data taken from trials in which various insecticides were compared. Under all conditions BHC and lindane were consistently effective. Endrin was probably next most effective when applied in granular formulation.

Each insecticide was rated as excellent when it gave 95 to 100% control, good when it gave 85 to 95%, fair when it gave 75 to 85%, and poor when it gave less than 75%. Under this scheme the following evaluations would apply.

Frequency of Rating of Various Granular Insecticides for Spittlebug Control

Insecticide	Excellent	Good	Fair	Poor	Total
BHC	20	18	2	1	41
Lindane	3	1			4
Endrin	4	7	2	2	15
Dieldrin	3	4	4	2	13
Toxaphene		1	1	2	4
Heptachlor			2		2
Aldrin				2	2

CLAY COMPARED WITH TOBACCO STEM CARRIERS

Two trials, one each in 1954 and 1955, were conducted to test clay formulations against tobacco stem preparations. In 1954 both formulations containing BHC were applied at two different times. The results, shown in Table 3, indicate that the clay preparation was superior. Table 9 shows the results of a test conducted in 1955 with both BHC and endrin on both carriers. In addition the endrin was prepared in two concentrations. In two instances the clay carriers were superior while in the third the tobacco preparation gave slightly better results.

RATES OF APPLICATION OF CARRIER

In general, practical rates of application for granular materials are in the neighborhood of 10 to 20 pounds per acre. In both 1954 and 1955 several tests were conducted in which the 10 pound per acre appli-

cation of a 2% material was compared with a 20 pound per acre application of a 1% material. Tables 2, 8, 9, 10, and 11 show the results of these trials.

Ten tests were conducted in which 10 and 20 pound rates of BHC were compared. In four of these the 20 pound rate was superior. In one trial the 10 pound rate was superior and in the other five the controls obtained were equivalent.

With endrin, the 10 pound rate was superior twice, the 20 pound rate was superior twice, while one trial showed equivalent results. Dieldrin in four trials showed two as equivalent and one each in favor of the 10 and 20 pound rates.

Evidently, no practical differences exist in the control obtained with the two rates of application.

TIMING GRANULAR APPLICATIONS

The timing of spittlebug insecticides might be classified into three general periods which occur 10 days to 2 weeks apart. Early is defined as the time of first hatch, optimum as the time at which the peak of hatch is occurring, and late as the time when the majority, if not all,

Fig. 1.—This is an experimental applicator made from the grass seed box of a drill.

hatch had occurred. During the early period the height of the foliage of the plants is usually small, 2 to 6 inches. The height of the foliage at the optimum time is usually 8 to 10 inches, although weather conditions may be such that growth is favored and the plants pass this stage rather rapidly. During the late period the crop is usually more than 12 inches high and penetration of the foliage cover with sprays is difficult.

Data presented in Tables 1, 3, 6, 10, and 11 are taken from trials in which insecticides were applied at different times which might be classified as above. Since BHC, dieldrin, and endrin were the most effective insecticides, only they will be considered. The same criteria for excellent, good, and fair that were used in the section on insecticide comparisons will be used here.

At the early time, BHC gave excellent control once and good control three times. Dieldrin gave good control once and poor control three times. Endrin gave good control in two trials.

At the optimum time, all three insecticides gave good or excellent control every time. BHC was used in ten trials, dieldrin in four, and endrin in three.

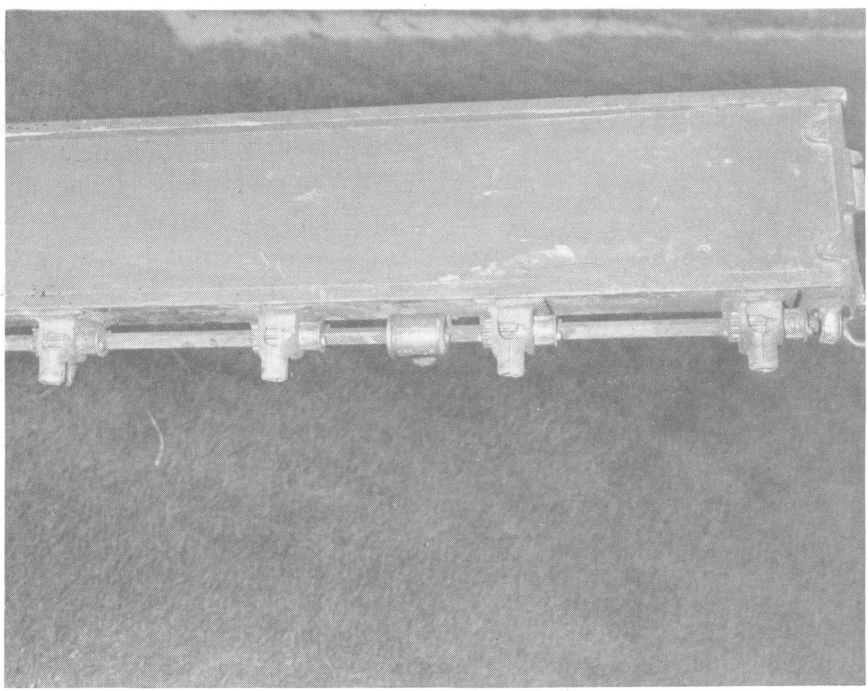

Fig. 2.—This shows the gear feed mechanism of the experimental applicator.

At the late time, BHC rated excellent in five of eight trials and good in the other three. Dieldrin rated excellent once but only fair in two trials out of three conducted. Endrin rated good once, fair twice, and poor once in four trials in which the insecticide was applied late.

It is evident that, among the insecticides tested, BHC was the only material in granular formulation that gave acceptable results over the entire range of timing. Optimum timing of the other materials resulted in good control, however.

AERIAL APPLICATIONS

In 1954 a single trial was conducted to test the effectiveness of the granular preparations when applied by air. Table 5 contains the results of this trial. The aerially applied BHC was practically equivalent in control to that obtained with a ground sprayer. Because the airplane must compete commercially with ground sprayers, this is a most important consideration. In 1955 a test was conducted to compare air and ground applied granulars with ground applied sprays. The granulars were put on at two different rates, 10 and 20 pounds per acre. Table 11 presents the results of this trial. At the optimum time, April 22, the control with aerial applications was as good as that with ground applications of either sprays or granules. At the late time, the 10 pound rate of application by air did not give as good results as did the other treatments. Indications are, however, that the airplane can compete with ground equipment as an application device for spittlebug insecticides.

SUMMARY OF CONCLUSIONS

1. Granular formulations of insecticides, especially BHC, gave control of spittlebugs that was equivalent to the control obtained with spray materials.
2. BHC was the most effective granular insecticide. Endrin was next best. Dieldrin and toxaphene were less satisfactory while heptachlor and aldrin were not effective.
3. BHC was the only material which gave satisfactory control when applied at other than the optimum time.
4. Clay formulations were better than tobacco formulations.
5. There was no practical difference between the controls obtained with 10 and 20 pound rates of application.
6. Aerial applications of BHC granules were as good as ground applied sprays.

APPENDIX

Summaries of the data from which the foregoing conclusions were drawn are presented in this appendix for the benefit of those who wish to examine the data in more detail.

Since the various trials were carried out under a variety of conditions and procedures, details of the experimental procedures are presented with each table.

TABLE 1.—Spittlebug control with toxaphene and dieldrin granules applied on two different dates. Wooster, Ohio, 1953

Insecticide	Carrier	Percent actual toxicant	Pounds actual toxicant per acre	Time of application	Percent control
Toxaphene	Attaclay	25	1.5	April 14	18.9
Toxaphene	Attaclay	25	1.5	May 6	63.2
Dieldrin	Bentonite	4	0.24	April 14	79.7
Dieldrin	Bentonite	4	0.24	May 6	96.0
BHC	Spray	0.31	0.25	May 8	99.9

Check, nymphs per stem—6.50.

Red clover was the host crop. The plots measured 9 by 50 feet and were replicated four times. The clay materials were applied with a wheelbarrow grass seeder. The sprays were applied with a conventional boom type "weed" sprayer. The counts were made May 18 and May 27, 1953.

TABLE 2.—Spittlebug control with dieldrin and BHC granules applied with a grain drill. Wooster, Ohio, 1954

Insecticide	Carrier	Percent actual toxicant	Pounds actual toxicant per acre	Time of application	Percent control
Dieldrin	Attaclay	1	0.25	April 26	91.8
Dieldrin	Attaclay	2	0.25	April 26	87.1
Lindane	Florex	2	0.25	April 26	97.0
BHC	Attaclay	1	0.25	April 26	99.6
BHC	Spray	0.31	0.25	April 26	99.1

Check, nymphs per stem—2.32.

Alfalfa was the host crop. The plots measured 10 by 50 feet and were replicated four times. The clay materials were applied through the grass box of a conventional grain drill. The spray was applied with a conventional boom type sprayer. The counts were made May 14, 1954.

TABLE 3.—Spittlebug control with several granular formulations applied with a grain drill on two different dates. Wooster, Ohio, 1954

Insecticide	Carrier	Percent actual toxicant	Pounds actual toxicant per acre	Percent control when applied	
				April 19	April 29
Lindane	Florex	2	0.2	95.6	94.3
BHC	Attaclay	1	0 2	88.6	93.0
BHC	Tobacco	2.5	0.25	50.6	83.5
Dieldrin	Attaclay	1	0.2	71.5	92.4
Heptachlor	Attaclay	1	0.2	79.7	77.8
Endrin	Tobacco	1	0.1	.	74.7

Check, nymphs per stem—1.58.

Alfalfa was the host crop. The plots measured 6 by 40 feet and were replicated four times. The clay material was applied through the grass box of a conventional grain drill. The counts were made May 17, 1954.

TABLE 4.—Spittlebug control with granular formulations applied with a grain drill. Wooster, Ohio, 1954

Insecticide	Carrier	Percent actual toxicant	Pounds actual toxicant per acre	Time of application	Percent control
Toxaphene	Attaclay	15	1.87	April 26	87.7
Aldrin	Attaclay	2	0.25	April 26	61.1
Lindane	Florex	2	0.25	April 26	98.8

Check, nymphs per stem—1.62.

Alfalfa was the host crop. The plots measured 10 by 50 feet and were replicated four times. The clay material was applied through the grass box of a conventional grain drill. The counts were made May 12, 1954.

TABLE 5.—Spittlebug control with dieldrin and BHC granules applied by airplane. Columbus, Ohio, 1954

Insecticide	Carrier	Percent actual toxicant	Pounds actual toxicant per acre	Time of application	Percent control
Dieldrin	Attaclay	1	0.25	April 24	55.3
BHC	Attaclay	1	0.25	April 24	94.1
BHC	Spray (ground)	0.31	0.25	April 21	96.8

Check, nymphs per stem—2.20.

Red clover was the host crop. The airplane plots were 75 by 800 feet and were replicated twice. The ground sprayed plots were 13 by 150 feet and were replicated four times. The aerial application was made through a conventional dust distributor mounted on a Stearman biplane provided by the School of Aviation of The Ohio State University. The ground sprays were applied with a conventional boom type sprayer. The counts were made on May 13, 1954.

TABLE 6.—Spittlebug control with 0.2 pounds of gamma BHC and endrin per acre applied on two different dates in spray and on granulars (attaclay). Wooster, Ohio, 1955

Insecticide	Carrier	Percent actual toxicant	Percent control when applied	
			April 15	April 28
BHC	Granular	1	99.0	97.4
BHC	Spray	0.25	99.2	94.7
Endrin	Granular	1	98.4	76.7
Endrin	Spray	0.25	96.3	92.3

Check, nymphs per stem—3.78.

Red clover was the host crop. The spray plots measured 14 by 50 feet and were treated with a conventional boom type sprayer. The granular plots measured 7 by 50 feet and were applied through a gear fed, grass seed box mounted on a wheelbarrow. All treatments were replicated four times. The counts were made May 21, 1955.

TABLE 7.—Spittlebug control with various insecticides on granular (attaclay) materials. Wooster, Ohio, 1955

Insecticide	Percent actual toxicant	Pounds actual toxicant per acre	Percent control
BHC	2	0.2	97.3
Endrin	2	0.2	94.1
Toxaphene	15	1.5	82.2
Aldrin	2	0.2	62.1

Check, nymphs per stem—2.19.

Red clover was the host crop. The plots measured 7 by 50 feet and were replicated four times. The granular materials were applied through a wheelbarrow mounted, gear fed, grass seed box. The counts were made May 12, 1955.

TABLE 8.—Spittlebug control with 0.2 pounds of gamma BHC granules (attaclay) prepared by commercial and "homemade" methods. Wooster, Ohio, 1955

Preparation	Percent actual toxicant	Percent control
Commercial	1	99.2
Homemade	1	99.6
Commercial	2	95.6
Homemade	2	99.2

Check, nymphs per stem—2.52.

Red clover was the host crop. The plots measured 7 by 50 feet and were replicated four times. The granular materials were applied through a wheelbarrow mounted, gear fed, grass seed box. The counts were made May 16, 1955.

TABLE 9.—Spittlebug control with 0.2 pounds of gamma BHC and endrin on clay and tobacco carriers. Wooster, Ohio, 1955

Insecticide	Carrier	Percent actual toxicant	Percent control
BHC	Attaclay	2	99.4
BHC	Tobacco	2	82.6
Endrin	Attaclay	2	88.7
Endrin	Tobacco	2	74.5
Endrin	Attaclay	1	86.1
Endrin	Tobacco	1	89.6

Check, nymphs per stem—3.45.

Red clover was the host crop. The plots measured 7 by 50 feet and were replicated four times. The granular materials were applied through a wheelbarrow mounted, gear fed, grass seed box. The counts were made May 18, 1955.

TABLE 10.—Spittlebug control with BHC, endrin, and dieldrin (attaclay) granules applied at two rates of carrier per acre on various dates. Wooster, Ohio, 1955

Insecticide	Percent actual toxicant	Pounds actual toxicant per acre	Percent control when applied		
			April 11	April 21	May 2
BHC	1	0.2	92.8	100.0	96.0
BHC	2	0.2	86.3	100.0	96.2
Average of both concentrations			89.5	100.0	96.1
Dieldrin	1	0.2	71.1	99.6	77.6
Dieldrin	2	0.2	93.7	99.6	76.5
Average of both concentrations			82.4	99.6	77.0
Endrin	1	0.2	85.9	100.0	77.1
Endrin	2	0.2	88.4	99.6	63.0
Average of both concentrations			87.1	99.8	70.0
BHC spray	0.25	0.2	April 28	96.0	

Check, nymphs per stem. .4.46.

Red clover was the host crop. The granular treated plots measured 7 by 50 feet; the sprayed plots and the checks measured 14 by 50 feet. All treatments were replicated four times. The granular materials were applied through a wheelbarrow mounted, gear fed, grass seed box. The sprays were applied with a conventional boom type sprayer. The counts were made May 19, 1955.

TABLE 11.—Spittlebug control with 0.2 pounds gamma BHC applied by air and ground machinery on two different dates. Grafton, Ohio, 1955

Type of equipment	Carrier	Percent actual toxicant	Percent control when applied	
			April 22	May 6
Air	Attaclay	1	99.9	95.3
Air	Attaclay	2	99.6	86.2
	Average of both concentrations		99.8	90.7
Ground	Attaclay	1	99.9	93.3
Ground	Attaclay	2	99.6	96.8
	Average of both concentrations		99.8	95.1
Ground	Spray	0.25	99.2	94.1

Check, nymphs per stem—2.53.

Red clover was the host crop. The airplane treated plots measured 100 by 300 feet; the ground sprayed plots measured 14 by 150 feet; the ground applied granular treated plots measured 7 by 150 feet. All treatments were replicated four times. The aerial treatments were applied by airplane equipped with a solid materials distributor designed by members of the Agricultural Engineering Department of The Ohio State University. The airplane was provided by the School of Aviation of The Ohio State University. The ground sprays were applied by the conventional boom type sprayer. The granular materials applied with ground equipment were applied through a wheelbarrow mounted, gear fed, grass seed box. The counts were made on May 23 and May 26, 1955.