RESEARCH CIRCULAR 144 DECEMBER 1965

Effectiveness of Insecticides Applied to Turf to Destroy Japanese Beetle Larvae

J. B. POLIVKA

OHIO AGRICULTURAL RESEARCH AND DEVELOPMENT CENTER
WOOSTER, OHIO

CONTENTS

* *

Historical Background ---------- 3

Materials and Procedure ---------- 3

Discussion and Results ---------- 7

Summary ---------- 10

References ---------- 11

Effectiveness of Insecticides Applied to Turf to Destroy Japanese Beetle Larvae

J. B. POLIVKA

It has been known for many years that a single application of an insecticide will eliminate Japanese beetle larvae from the soil for a period of 10 or more years. The results of tests established from 1945 to 1949 have been so effective that in most cases the original applications have kept the turf free of grubs up to the present time.

In the original experiments, different insecticides were applied at different rates to find the most effective toxicant and the most practical rate that could be recommended to the general public for the control of this turf grub. Since different insecticides and formulations of various insecticides became available at different times, all were not under test for the same period of time.

This paper is the final report of tests established in cemeteries, parks, and golf courses from 1945 to 1949. Many of these plots had to be abandoned in the past 2 years because one or more replicates were used for burials or an entire area was treated with insecticides to eliminate other insects.

HISTORICAL BACKGROUND

Leach (2) reported an experiment which demonstrated that Japanese beetle larvae die when they feed in soil containing certain arsenates. Fleming and Osburn (1) stated that lead arsenate was very effective when applied at the rate of 10 lb. per 1,000 square feet of surface.

Polivka (3) found that the 10 lb. rate was as effective as 12.5 or 15 lb. rates after lead arsenate was in the soil for a full year. In 1959, Polivka (4) reported upon the earlier effectiveness of many insecticides mentioned in this paper.

MATERIALS and PROCEDURE

In most of the tests, the insecticides used were those formulated to be sold on the retail market. The different chemicals were applied at various times as wettable powders, emulsifiable concentrates, dusts, or granules. Wettable powders were mixed with water or milorganite as a carrier. Emulsifiable concentrates were mixed with water in all cases. Free-flowing granular materials were mixed with milorganite or applied without a carrier.

Liquid applications to small plots of less than 300 square feet were made with a sprinkling can. Dry materials were applied to the soil surface with an 18-inch fertilizer spreader, a hand sifter, or a knapsack seeder.

In most tests, the plots were arranged in randomized blocks and varied in size from 100 to 1,000 square feet. In small plot tests, there were usually four or five replicates. Larger plot tests were only single plots or treatments were replicated two or three times.

From 1945 to 1956, the population records were obtained by examining the soil for larvae in three 1/3-square-foot samples in plots 100 square feet in size. More samples were examined for grubs in the larger plots.

Since 1957, the data were obtained by examining the soil for larvae in three 1/12-square-foot samples in plots of 100 square feet. More samples were examined for grubs in the larger plots. The core samples were taken to a depth of 4 or more inches, depending upon the depth of the larvae at the time of the survey.

Figure 1 shows the 1/3-square-foot sampler, the size of soil core obtained with the sampler, and the portable table used to examine the soil for larvae. Figure 2 shows the 1/12-square-foot samplers and the board upon which the soil is examined for Japanese beetle grubs. The hole-cutter type of sampler is used when the larvae are below the 4-inch level and the other one is used when the larvae are feeding near the surface.

In general, the insecticide program was set up to determine the residual effect over a long period of time. To determine the initial mortality, grub population records were usually taken about 30 days after the application date. Subsequent records to measure residual effectiveness were taken either in September or October of one year or in April or May of the next year.

In Table 1, the insecticides are reported present in the soil for a certain number of generations of the Japanese beetle. The number of generations is comparable to the number of larval stages exposed to the insecticide in the soil. Whenever an insecticide was applied to turf 30 days or more before pupation in late May, the insecticide was considered to be in the soil for a long enough period to be regarded present against one generation of the insect. When the same plots were checked the following September or October or in April or May, the insecticide was considered to be present in the soil for two generations of the insect. Each successive survey was conducted on another new generation.

Fig. 1.—The 1/3-square-foot sampler, portable table, and size of cores removed for examination.

Fig. 2.—1/12-square-foot samplers and the board used in examining soil for Japanese beetle larvae.

TABLE 1.—Residual Effectiveness of Insecticides Applied to Soils for Control of Japanese Beetle Larvae.

Toxicant	Formulation	Rate in Lb. per Acre	No. of Tests	No. of Larval Generations Exposed to Treated Soil	Percent Control at Last Survey Date	Range of Pop./Sq. Ft. in Check
Aldrin	2% gran.	2	2	2	100.0	4-9
	5% gran.	2-10	12	1-12	100.0	2-22
	2 lb./gal. EC	1-2	7	1-6	100.0	5-10
Bandane	7.5% gran.	2-30	9	1-2	100.0	6.8-20
	4 lb./gal. EC	10-30	3	1	100.0	10
Chip-Cal		680	1	5	100.0	13
Chlordane	5% gran.	1-30	12	1-7	94.9	2-22
	10% gran.	2.5-7	4	2-6	100.0	2-19
	40% WP	1-25	12	13-14	100.0	4-11
	8 lb./gal. EC	1-25	8	1-17	100.0	3.2-19.1
DDT	5% gran.	25-50	4	3-6	100.0	2-19
	50% WP	12.5-37.5	9	13-17	71.1	3.2-12
	25% EC	25	1	9	100.0	13
Dieldrin	2% gran.	2	2	2	100.0	4-9
	4% gran.	1-3	3	1-12	100.0	2-21.5
	5% gran.	2-6	10	3-8	100.0	2-22
	10% gran.	1-5	4	2-3	100.0	2-21.5
	1.5 lb./gal. EC	1-3	9	1-7	100.0	5-13
	18.5% EC	3	1	9	100.0	13
Endrin	1% gran.	3	1	5	100.0	19
	2% gran.	2	1	2	100.0	4
	4% gran.	2	1	1	100.0	5
	5% gran.	2-3	4	3-6	100.0	2-22
	1.6 lb./gal. EC	1-2	7	1-6	100.0	5-10
	19 5% EC	3	1	2	100.0	19.1
Heptachlor	5% gran.	2-10	11	1-5	100.0	4-10
	10% gran.	20	1	6	100.0	3
	25% WP	1-20	5	12-15	100.0	2
	2 lb./gal. EC	1-2	8	1-7	100.0	5-13
Heptachlor-epoxide	5% gran.	1-6	8	1	100.0	3-10
Lead arsenate		453	7	2-17	62.0	2-19.1
		906	3	1-15	71.7	3-5
		1359	1	15	100.0	4.4
Telodrin	2% gran.	2-10	5	1-3	100.0	4-9
	5% gran.	2-10	7	1-4	100.0	2.6-20
	1¼ lb./gal. EC	2	1	2	100.0	19
Toxaphene	10% gran.	25-75	2	8	100.0	5
	25% gran.	6-24	3	3-12	98.0	2-21.5
Zectran	2 lb./gal. EC	5	1	1	100.0	5
Zytron	8% gran.	20	1	5	46.7	13

DISCUSSION and RESULTS

The results of these studies (Table 1) indicate that a single application of an insecticide will grub-proof turf for a long period of time. For instance, it was found that lead arsenate, DDT, and chlordane were very effective for 17 generations of the Japanese beetle. The efficacies of these and many of the other insecticides have not been resolved because a large number of these tests had to be discontinued before the insecticides became ineffective.

A brief discussion of each insecticide follows:

Aldrin: This insecticide was used in 21 different tests and applied in one or more tests as a 2 or 5 percent granular compound or as a 2 lb. per gallon emulsifiable concentrate. The 2 percent granular formulation was used in one test at a rate of 2 lb. of the actual material per acre, the 5 percent material was applied at a rate of 2 lb. per acre in three tests, at a 3 lb. rate in four tests, and at a 6 lb. rate in one test. The 2 lb. per gallon emulsifiable concentrate was used at a 1 lb. rate in one test and at a 2 lb. rate in two tests.

All formulations and all rates of the different formulations were found to be 100 percent effective for the duration of these studies. In one test, a 3 lb. rate completely eliminated the Japanese beetle larvae from the test plots for 12 generations of the insect. It is reasonable to assume that this particular plot may be free of grubs for several more years and that the insecticide in the other tests will be equally effective.

Bandane: This herbicide appears to have some insecticidal properties. When this material was applied to turf in March for pre-emergence control of crabgrass, Japanese beetle larval population was controlled the following fall. Some results indicate that the 10 and 20 lb. rates were effective for two generations of the insect. However, results obtained from some earlier unreported tests indicated that Bandane cannot be expected to give control for more than 1 year.

Chip-Cal: This calcium arsenate compound was very effective in controlling Japanese beetle grubs in the only test in which it was used. Chip-Cal is recommended as a pre-emergence crabgrass killer. It appears that when it is used as a herbicide, there is no need to apply an insecticide for the control of turf grubs.

Chlordane: This chlorinated hydrocarbon insecticide was used in 26 tests. A 5 percent granular material was applied at rates of 1, 2, 4, 7.5, 10, and 30 lb. of the actual material per acre in one test each; at a 2.5 lb. rate in two tests; and at a 5 lb. rate in four tests. A 10 percent granular material was applied at a 5 lb. rate in two tests and at a 7 lb. rate in one test. A 5 percent dust was applied at a 2.5 lb. rate in

only one test. A 40 percent wettable powder was applied at rates of 1, 15, 20, and 25 lb. in one test each and at 5 and 10 lb. rates in two tests each. The 8 lb. per gallon emulsifiable concentrate was applied at 1, 15, and 25 lb. rates in one test each and at 5 and 10 lb. rates in two tests each.

All formulations and all rates of the various formulations were very effective except for the 1 and 2.5 lb. rates that were in the soil for only seven generations of the Japanese beetle. The data indicate that the 5 lb. rate was as effective as the 10 lb. rate in all tests. The 5 lb. rate gave complete control of the grubs for 17 generations of the insect.

DDT: This insecticide replaced lead arsenate for control of the Japanese beetle as soon at it was made available for general distribution. It was cheaper and preliminary tests indicated that it was as effective as lead arsenate in controlling grubs.

This insecticide was used in 14 different tests. A 5 percent granular material was applied at a rate of 25 lb. of the actual material per acre in three tests and at a 50 lb. rate in one test. A 50 percent wettable powder was applied at a 12.5 lb. rate in four tests, at a 25 lb. rate in four, and at a 37.5 lb. rate in one test. A 25 percent emulsifiable concentrate was applied at a 25 lb. rate in only one test.

This compound is very similar to lead arsenate in its effectiveness. In some areas, the 25 lb. rate ceased being effective after it was in the soil for six generations (4). In this report, however, the same rate was still very effective after being in the soil for 14 and 17 generations of the insect.

Dieldrin: This insecticide was used in 29 tests. A 2 percent granular material was applied at a rate of 2 lb. of the actual toxicant per acre in one test. A 4 percent granular material was applied at 1, 2, and 3 lb. rates in one test each. A 5 percent granular material was applied at a 2 lb. rate in four tests, at a 3 lb. rate in three tests, and at a 6 lb. rate in one test. A 10 percent granular material was applied at 1 and 5 lb. rates in one test each and at a 2 lb. rate in two tests. A 1.5 lb. technical per gallon emulsifiable concentrate was applied at a 1 lb. rate in one test, at a 2 lb. rate in three tests, and at a 3 lb. rate in two tests.

All formulations and rates of application were effective in controlling Japanese beetle larvae wherever dieldrin was applied in Ohio. One of the 3 lb. rate tests was 100 percent effective after being in the soil for 12 generations of the insect.

Endrin: This insecticide was applied as a 1 percent granular material at a rate of 3 lb. of the actual toxicant per acre in one test, as a 2

and 4 percent granular material at a 2 lb. rate in two tests each, as a 5 percent granular material at 2 and 3 lb. rates in two tests each, as a 1.6 lb. technical per gallon emulsifiable concentrate at 1 and 2 lb. rates in three tests each, and as 19.5 percent emulsifiable concentrate at a 3 lb. rate in one test.

The data show that the 1 and 2 lb. rates were very effective after being in the soil for six generations of the insect.

Heptachlor: This chemical was applied as a 5 percent granular material at 2 and 3 lb. rates in three tests each and as a 10 percent granular material in one test. A 25 percent wettable powder was applied at 1, 10, and 20 lb. rates in one test each and at a 5 lb. rate in two tests. A 2 percent emulsifiable concentrate was applied at a 1 lb. rate in one test and at a 2 lb. rate in three tests.

In the test in which the effectiveness of heptachlor was studied for 15 generations of the insect, the plots treated at the 1 lb. rate were free of grubs when the beetle population was low in the untreated areas; in years when the populations were high, one or more larvae were found at this particular insecticide level. In other 1 lb. rate tests, no larvae were found during these experiments.

Heptachlor-Epoxide: This chemical was very effective when applied as a 5 percent granular material at rates of 1, 2, 3, 4, and 6 lb. of the actual toxicant per acre for one generation of the insect. These studies will be continued.

Lead Arsenate. This material was applied at rates of 453, 906, and 1359 lb. per acre. Lead arsenate is somewhat erratic in its effectiveness. For instance, in one test the 453 lb. rate was very effective for 17 generations of the insect; in another test the same rate ceased being effective after being in the soil for six generations.

Telodrin: This insecticide was applied as a 2 percent compound at a rate of 2 lb. of technical material per acre in three tests and at a 10 lb. rate in one test. A 5 percent granular material was applied at a 2 lb. rate in three tests and at 4, 5, 6, and 10 lb. rates in one test each. A 1.25 lb. technical per gallon emulsifiable concentrate was applied at a 2 lb. rate in one test.

Since this insecticide is a relatively new compound, it has been under study for only four generations of the Japanese beetle. All rates used were found to give 100 percent control of turf grubs.

Toxaphene: A 10 percent granular formulation of this insecticide was applied at rates of 25 and 75 lb. of the actual material per acre in one test. A 25 percent granular formulation was applied at rates of 6, 18, and 24 lb. per acre in one test.

The 24 lb. rate was very effective for 12 generations of the insect. The lower rates were fairly effective for three generations.

Zectran: This chemical was very effective for one generation of the Japanese beetle when a 2 lb. technical per gallon emulsifiable concentrate was applied at a rate of 5 lb. per acre.

Zytron: This is another herbicide with insecticidal properties. When Zytron was applied at a rate of 20 lb. of the actual material per acre in the spring, it was found to be very effective against the grub population the following fall. However, it was not effective against the second generation.

SUMMARY

These data indicate that the formulation did not make any difference in effectiveness of any of the insecticides. For example, the 5 lb. rate of chlordane was equally effective when applied as an emulsifiable concentrate, as a wettable powder, or as granules. However, the lower rates of chlordane in these same tests were not equally effective. In one test of the 1 lb. rate of chlordane, the grub population was not significantly different from that in the check plot. In the other tests, the 1 lb. rate of chlordane gave complete control of the grubs. Previous histories of the plots have shown that when the population was high in the untreated areas, a few larvae were found in all plots treated with chlordane at the 1 lb. rate.

The 1 lb. rates of aldrin, dieldrin, heptachlor, endrin, and Telodrin were effective in all tests.

Two herbicides, Bandane and Zytron, were very effective in eliminating the first generation of the Japanese beetle appearing after the early spring application of these materials for the control of weeds in turf.

The data indicate that aldrin, chlordane, dieldrin, heptachlor, lead arsenate, and toxaphene persist in turf soils for a long period of time. Since Telodrin and endrin are similar to these chlorinated hydrocarbon insecticides, it is assumed that they will be as effective for the same period of time. These data also indicate that the amount of actual insecticide applied was the important factor in obtaining complete control of Japanese beetle larvae.

REFERENCES

1. Fleming, W. E. and M. R. Osburn. 1932. Control of Larvae of the Japanese and Asiatic Beetles in Lawns and Golf Courses. U. S. D. A. Circ. 238.

2. Leach, B. R. 1926. Experiments with Certain Arsenates as Soil Insecticides. Jour. Agri. Res. Vol. 33, p. 1.

3. Polivka, J. B. 1947. Control of the Japanese Beetle Larvae in Soil. Ohio Agri. Exp. Sta. Ohio Farm and Home Research 32 (247): 146.

4. Polivka, J. B. 1959. The Biology and Control of Turf Grubs. Ohio Agri. Exp. Sta. Res. Bull. 829.