

INSECT PROBLEMS THAT DEVELOP ON ALFALFA FOLLOWING TREATMENT WITH CERTAIN INSECTICIDES¹

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Since the close of World War II many new organic insecticides have been developed and released by manufacturers. In experimental tests, many have proved to give more effective control of certain insect pests than do materials previously recommended. Others need further investigation of their effects on insects, on plants, and on man before their use can be recommended.

The indiscriminate use of many of the new organic insecticides may create more serious problems than is generally recognized. DDT had been used only a short time when investigators began reporting such strange effects as the buildup of certain insect populations, creating new problems more serious than the problem before treatment.

This was particularly true with certain aphids and mites. Serious aphid increases have been reported by Stevenson et al. (1944), Loftin (1944), Baker, Howard, and Porter (1945), Eberling (1945), Hervey (1946), Newcomer, Dean, and Carlson (1946), Wheeler and LaPlante (1946), and Sylvester (1949) following the use of DDT. Mite increases have been reported by Loftin (1944), Eberling (1945), Gray (1945), Hough (1946), Driggers (1946), Michelbacher et al. (1946), Wheeler and LaPlante (1946), and DeBach (1947). Increases in scale insects have been reported by Woglum (1946), Middlekauff et al. (1947), and Michelbacher et al. (1947). Wilson (1949) reported increased populations of potato leafhoppers, *Empoasca fabae* (Harris), following treatment with chlordane.

DDT and other new organics are not the first insecticides reported to effect an increase in the population of certain insects following their use. Folsom (1927, 1930), Dunham and Clark (1941), Smith and Fontenot (1942), and Elmore and Campbell (1943) reported aphid increases following the use of calcium arsenate, while Hill and Tate (1943) reported similar effects on aphid populations sprayed with zinc arsenite.

During the three successive years of 1948, 1949, and 1950, the authors conducted studies testing most of the new organic insecticides for possible use to control insects on alfalfa. Each year the populations of the potato leafhopper, *Empoasca fabae* (Harris), increased after treatment with chlordane, aldrin, or dieldrin. Of the three years, 1950 was the only year in which populations of pea aphid, *Macrosiphum pisi* (Kalt), were large enough in the experiments to obtain useful data. Tremendous population increases of this insect were observed on dieldrin and toxaphene plots.

DDT is very effective in controlling both the potato leafhopper and the pea aphid, and a high residual action was observed four weeks after treatment. DDT was used as a standard for comparison with untreated and insecticide treated plots on which the populations increased.

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METHODS

Plot size and arrangement. The following plot sizes have been used: 30 x 200 feet, 20 x 40 feet, 20 x 60 feet, and 30 x 30 feet. Treatments were replicated from 4 to 8 times in all experiments. Because certain insect populations increased following the application of some materials, a Latin-square design with eight treatments was tried to determine if the population build-up might be due to position effect.

Equipment. Materials were applied with a small experimental sprayer mounted on bicycle wheels and equipped with a 10-foot boom for legume spraying. Sprays were applied at 40 pounds pressure using CO₂ as a propellant. A speedometer was attached to the sprayer so that accurate dosages could be applied to treated plots. Insecticidal treatments were applied in July to the second alfalfa crop just prior to breaking into bloom. All alfalfa of the second crop surrounding the experimental area was cut for hay. The experimental plots were allowed to set seed.

Insect sampling. Insect populations were sampled one week and four weeks after treatment with an insect sweep net, 20 sweeps being made in each plot. The alfalfa experimental plots were always sampled for insects on warm, clear days between the hours of 10 A.M. and 3 P.M.

TABLE 1

Comparison of *F* values for actual data and data transformed by $\sqrt{X + 0.5}$

Insect	Experiment	Time	Calculated <i>F</i> Value		Required for Significance	
			Actual Counts	Transformation	<i>F</i> .05	<i>F</i> .01
Leafhopper	1-1948	1 wk.	7.95	0.46	2.90	4.56
"	" "	4 wks.	10.71	15.78	2.90	4.56
"	2-1949	1 wk.	10.73	20.95	2.10	2.83
"	" "	4 wks.	10.48	10.46	2.10	2.83
"	3 "	1 wk.	7.13	15.38	2.24	3.10
"	" "	4 wks.	8.36	14.38	2.24	3.10
"	4-1950	1 wk.	4.33	5.83	2.15	2.94
"	" "	4 wks.	11.02	12.43	2.46	3.60
Aphid	" "	1 wk.	6.94	11.17	2.15	2.94
"	" "	4 wks.	3.56	4.11	2.46	3.60

EXPERIMENTAL RESULTS

Leafhoppers—*Empoasca fabae* (Harris)

Data first analyzed by analysis of variance showed significant leafhopper population increases on chlordane, aldrin, and dieldrin treatments. Analysis also showed that the position of the plot in the field had no significant effect on the treatment. Leafhopper populations built up regardless of the treatment location.

Because the insect counts are not normally distributed, the analysis was repeated transforming the data by $\sqrt{X + 0.5}$. This analysis increased the significance of the differences in most cases. Table 1 compares *F* values of the analysis from actual data with the analysis from transformed data. Since the transformation increased the significance of the differences, the original data with calculated least significant differences are included in tables 2 and 3.

Chlordane effects. Data in table 2 show that when chlordane was applied at the rate of one pound per acre, one week after treatment in experiment 1 the leafhopper population was increased, but not significantly. In experiment 2 the population was slightly, but not significantly, lower on treated than on untreated plots. In experiment 3 the population showed a trend to increase which was not

TABLE 2

Comparison of populations of *E. fabae* (Harris) in chlordane, aldrin, and dieldrin plots with untreated and DDT treated plots; one week and four weeks after treatment.

TREATMENT	NUMBER OF LEAFHOPPERS PER 20 SWEEPS AFTER TREATMENT							
	1948 Experiment 1		1949 Experiment 2		1949 Experiment 3		1950 Experiment 4	
	1 wk.	4 wks.	1 wk.	4 wks.	1 wk.	4 wks.	1 wk.	4 wks.
Untreated	39	113	41	86	61	108	45	189
DDT								
2 lb. per acre	1	6	4	31	4	7	8	51
Chlordane								
1 lb. per acre	93	353	31	130	93	78	..	..
Aldrin								
0.5 lb. per acre	..	..	..	..	144	253	..	..
Dieldrin								
0.5 lb. per acre	..	..	43	132	..	..	39	517
L. S. D. .05	non. sig.	127	14	35	52	81	19	135
" .01	non. sig.	175	19	47	69	109	26	185

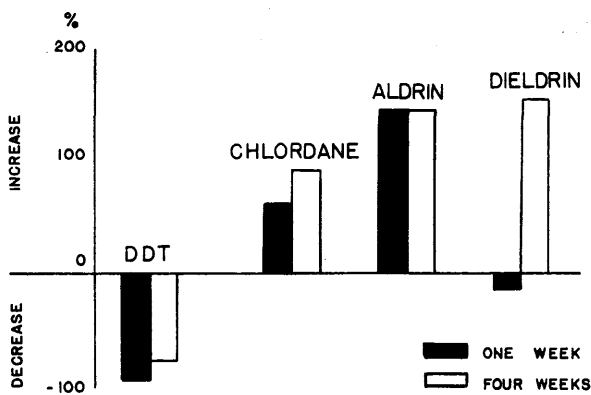


FIGURE 1. Comparison of percent increase of *E. fabae* due to chlordane, aldrin, or dieldrin with percent decrease due to DDT based on untreated plots.

significant one week after treatment. Four weeks after treatment, the leafhoppers in experiments 1 and 2 showed a tremendous population build-up.

Dieldrin effects. When dieldrin was applied at the rate of one-half pound per acre, two experiments showed no increase in population one week after treatment. However, four weeks after treatment, the leafhopper population increase in both experiments was very large.

Aldrin effects. Aldrin was tested in only one experiment. This one experiment indicated that the population build-up with aldrin at the rate of one-half pound per acre was more rapid than either with chlordane at the one pound rate or with dieldrin at the one-half pound rate. Within one week aldrin plots reached a much higher population build-up than either chlordane or dieldrin plots. Also, the only experiment where chlordane did not cause a population increase was experiment 3 in which the increases in the aldrin plots were so high.

Data on leafhoppers from all experiments were averaged and the percentage change in populations calculated. The data are presented in figure 1.

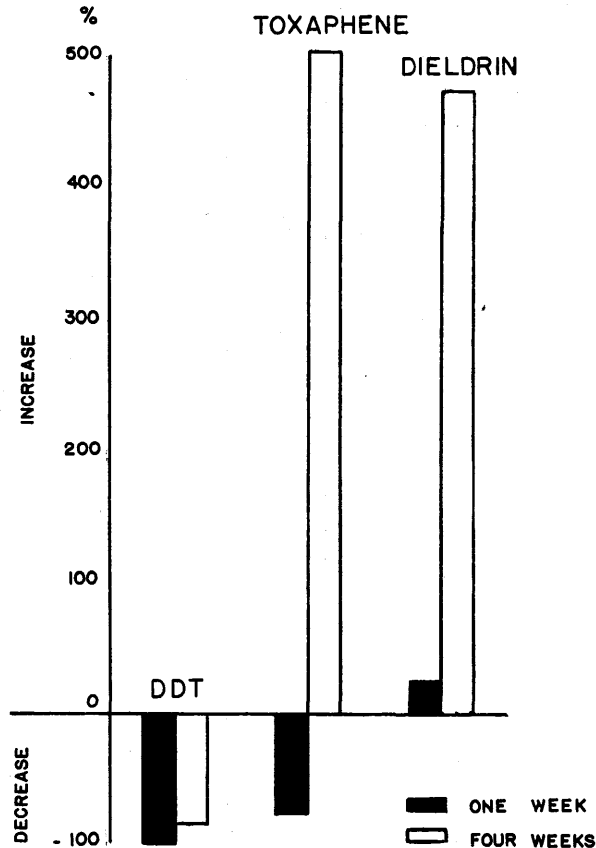


FIGURE 2. Comparison of percent increase of *M. pisi* due to dieldrin or toxaphene with percent decrease due to DDT based on untreated plots.

Aphids—*Macrosiphum pisi* (Kalt.)

Sufficient aphid populations to obtain adequate data developed only in the 1950 season. The *F* values for actual data and transformed data are included in table 1. In each case significance of the data was increased when the data were analyzed using the $\sqrt{X + 0.5}$ transformation.

In table 3 original data tabulated from population counts of the pea aphid, *Macrosiphum pisi* (Kalt), are included together with the calculated differences required for significance. These data are presented as a preliminary report showing possible trends from the use of certain insecticides on this insect. Although DDT does not control many species of aphids, it is highly effective against the pea aphid. In table 3, the effects of toxaphene and dieldrin are compared with the highly effective residual effect of DDT. Toxaphene effected significant control of the aphid one week after treatment at a dosage of three pounds per acre. However, four weeks after treatment surviving aphids built up their population 518 percent. A dosage of one-half pound of dieldrin showed an increased population trend under significance the first week, but a significant 466 percent increase four weeks later. These data are presented in figure 2.

TABLE 3

Comparison of populations of M. pisi (Kalt.) in dieldrin and toxaphene plots with untreated and DDT treated plots; one week and four weeks after treatment.

TREATMENT	NUMBER OF APHIDS PER 20 SWEEPS	
	1 week	4 weeks
Untreated	116	53
DDT		
2 lb. per acre	6	9
Toxaphene		
3 lb. per acre	32	330
Dieldrin		
0.5 lb. per acre	133	302
L. S. D. .05	55	185
" .01	74	254

SUMMARY

In conjunction with studies on the control of alfalfa insects, observations were made which showed that certain insect populations instead of being reduced by certain insecticides may be increased in numbers. Three field experiments showed that populations of the potato leafhopper, *Empoasca fabae* (Harris), may increase following treatment with per acre dosages of one pound of chlordane, one-half pound of aldrin, or one-half pound of dieldrin. Similar effects were noted in 1950 to occur to populations of the pea aphid, *Macrosiphum pisi* (Kalt.), following treatment with one-half pound of dieldrin or 3 pounds of toxaphene.

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