Studies on Chemical Control of Insects Affecting Alfalfa Seed Production

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The farmer who desires to produce alfalfa seed in Indiana is confronted with many problems which may interfere with obtaining a successful seed yield. Foremost, are the problems of injurious insects, diseases, pollination, and the lack of alfalfa varieties inherently adapted to seed production in the State.

Numerous reports have been made by investigators on the damage that insects may do to alfalfa. Before the dawn of the era of new organic insecticides for the science of applied entomology, insects might have been the most important limiting factor in alfalfa seed production, for damage was so severe in some areas as a result of insect infestation that seed production was generally unprofitable. Today, because of these new insecticides, the insect problem need not be the one of prime importance in most cases.

Following World War II when DDT was released, investigators studied the use of this new material on alfalfa for seed production. Poos, (1945) found DDT to be effective against the potato leafhopper, *Empoasca fabae* Harris; Lieberman, (1946) and Sorenson and Carlson, (1946) found that seed yields of alfalfa could be increased in Utah by controlling plant bug species with DDT. Pederson (1948) showed that some insects only moderately controlled by DDT were controlled by BHC, and found that chlordane and toxaphene were especially effective against grasshoppers.

Wilson, (1949) initiated studies in 1948 on the use of organic insecticides to control alfalfa insects in Indiana. Since that time studies have been continued in the vicinity of Lafayette on heavy soils and in northern Indiana on sandy soils at the Purdue Sand Field in Culver. The Departments of Agronomy and Entomology at Purdue have cooperated to determine the damage caused by insects and the insect problems involved in Indiana in alfalfa seed production as well as the use of new organic insecticides for control of these insects. Information was desired not only on the toxicities and residual effects of these new materials, but also on the effects on pollination, seed yields, and insect populations not controlled by these insecticides. Wilson and Davis (1952) have reported how leafhopper and aphid populations may build up to tremendous numbers following the use of certain insecticides on alfalfa. This paper reports results obtained from five field experiments conducted during the seasons of 1949, 1950, and 1951.

Methods

Seed production studies in all experiments were made on the second alfalfa crop. The first crop was harvested for hay and the second allowed to set seed as is generally the practice. These studies were made using single prebloom insecticidal treatments which were applid when the plants were budded but not blooming. Normally, in Indiana, this is between

July 10 and 15 although it may vary depending on the management of the alfalfa.

In all experiments, randomized replicated plot designs; or where possible, to increase precision, Latin-square designs have been used. Plot sizes of 20 x 40 feet, 20 x 60 feet, 30 x 30 feet, and 30 x 40 feet have been employed. Significant differences in data were obtained with all plot sizes used.

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 CO_2 as a propellent. A speedometer was attached to the sprayer so that accurate dosages could be applied to treated plots.

INSECT SAMPLING: Insect populations were sampled one week, four weeks, and in one experiment, seven weeks after treatment with an insect sweep net; 20 sweeps being made in each plot. The sampling was always made on warm, clear days between the hours of 10 A. M. and 3 P. M.

HARVEST DATA: Harvest data consisted of both seed yields and evaluation of racemes for insect injury and pollination. Seed yields were obtained by harvesting 60 to 81 square feet in the center of each plot. To determine insect damage and pollination, twenty-five alfalfa stems picked at random were sampled in each plot. From these stems the per cent of racemes that developed and the per cent that aborted were determined and the number of racemes bearing pods as well as pods per raceme were measured to give an index of pollination.

POLLINATION: In experiments 1, 2, and 3 pollination was effected by various species of solitary bees. At the Westpoint locality this method was quite satisfactory because the experimental field was surrounded by a wooded area harboring numerous wild bees. (megachilids and andrenids).

In experiments 4 and 5 at Culver it was necessary to use honey bees since populations of the solitary bees were scarce. Honey bees show considerable promise as alfalfa pollinators and it is believed they may be successfully used in Indiana, when more is learned about bee management for seed production in this area. In 1950, when it was found that natural pollinators were not effecting pollination at Culver, bees were moved into the experimental plots after half of the bloom had withered. However, the bees pollinated the remaining bloom so that the terminal flowers of nearly all racemes produced seed pods. One and a half bushels of cleaned seed per acre were produced on the better treatments and the yield would probably have been more than doubled had the bees been placed in the field earlier.

Injurious Insects

The insect species found to be most important in alfalfa seed production were the potato leafhopper, *Empoasca fabae* (Harris), the tarnished plant bug, *Lygus oblineatus* (Say), the alfalfa plant bug, *Adelphocoris lineolatus* (Goez), the rapid plant bug, *A. rapidus* (Say), the pea aphid, *Macrosiphum pisi* (Kltb.), the grasshoppers, *Melanoplus sp.* and *Conocephalus sp.* Also present in large numbers were the adults of the meadow

spittlebug, *Philaenus leucophthalmus* (L) which have not been found to be injurious to alfalfa in the adult stage.

Experimental Results

Insect data for experiments 1, 2, 3, 4, and 5 are tabulated in tables I, II, III, V, and VII. Harvest data including seed yields and individual raceme data are included in tables IV, VI, and VIII, and correlations made in experiment 5 are presented in table IX. To facilitate comparisons of insecticide toxicities, all toxicological data have been averaged and converted to a rating system and are included in table X. Examination of the tables will show the following results:

POTATO LEAFHOPPER: In five field experiments DDT has been applied at per acre dosages ranging from 0.5 to 3 pounds. Although the same treatments were not repeated in all experiments, all rates effected significant control. The residual effect of DDT as measured by the number of leafhoppers four weeks after treatment was significant for all concentrations with the exception of one experiment (table III). However, in this experiment there was a pronounced trend toward residual control at a rate of 1.75 pounds of DDT per acre.

Chlordane, aldrin, or dieldrin were non-effective or resulted in increased populations when used. However, when these materials were combined with 1 pound of DDT, 0.5 or 1 pound of chlordane, or dieldrin, control of leafhoppers with a residual effect four weeks after treatment was obtained.

Dosages of 2 to 3 pounds of toxaphene per acre were effective as residual sprays, but at the same rate there was a trend toward DDT being superior. When one pound of toxaphene was combined with one pound of DDT, control equivalent to two pounds of DDT seemed to be apparent. A dosage of 2 pounds of methoxychlor was used with residual results while two pounds of TDE effected initial control, but the residual effect was non-significant. Concentrations of 0.5 and 1 pound of Systox had residual effects. One pound of Systox was superior to 0.5 pound in initial kill, but differences were not significant four weeks later.

Initial kill was obtained with both 0.5 and 1 pound of parathion and 0.5 pound of EPN. With one exception (paration, 0.5 lb., table I) parathion and EPN had no residual effect.

Concentrations of 0.25 to 0.5 pound of lindane, 0.5 pound of gamma BHC and 0.2 pound CS-645A were non-effective.

PLANT BUGS: All three species of plant bugs previously mentioned will be considered together since materials found to be toxic to one species, likewise were toxic to the other two.

Dieldrin at rates of 0.5 and 1 pound per acre was the most effective material used against plant bugs. In one experiment (table III) when population counts were made seven weeks after treatment the 0.5 pound rate continued to effect control at the 5 per cent level of significance while the 1 pound rate of dieldrin remained significant at the one per cent level.

Results with DDT were variable. Concentrations of 1.5 pounds of DDT per acre gave high residual control of plant bug nymphs. Residual effect continued on plant bug nymphs seven weeks after treatment at a dosage of 1.75 pounds of DDT.

The adult plant bugs are more difficult to control and dosages as high as 3 pounds of DDT per acre do not always effect control (table VII).

Parathion, dieldrin, and DDT were superior to TDE and toxaphene which in turn effected higher residual control of plant bug nymphs than methoxychlor and chlordane. Except for one case against nymphal populations (table I) parathion had no residual effect. Concentrations of 0.5 pound of EPN and 0.5 to 1 pound of Systox were non-effective.

Residual control was obtained with 3 pounds of toxaphene. Concentrations of 0.25 and 0.5 pound of lindane controlled plant bugs one week after treatment, but had no residual effect four weeks later.

In combination, there was a trend toward 0.5 pound of dieldrin with 1 pound of DDT being superior to either 1 pound of chlordane or 1 pound of toxaphene combined with 1 pound of DDT.

PEA APHID: In general, concentrations of 3 pounds of DDT, 1 pound of DDT in combination with .5 and 1 pound of dieldrin, 1 pound of dieldrin, and .5 to 1 pound of Systox effected residual control of the pea aphid four weeks after treatment.

High initial kill one week after treatment, but without residual effect four weeks after treatment, was obtained with a low dosage of 0.5 pound of DDT, 1 pound of DDT in combination with 1 pound of chlordane, 1 pound of toxaphene, or 0.5 pound dieldrin, and 0.25 pound lindane, 0.5 pound parathion, or 3 pounds of toxaphene. In general, concentrations of 0.5 pound EPN and 0.5 pound dieldrin were non-effective.

GRASSHOPPERS: Of the three years, 1949, 1950, and 1951, 1949 was the only year in which grasshopper populations large enough for study were encountered. Although data in experiment 1 show highly significant differences in treatments, the populations are too low to use as a measure. However, toxaphene, chlordane, parathion, and dieldrin do appear to have effected better grasshopper control than other materials studied.

In experiment 2 (table II) where grasshopper populations were higher, toxaphene at the rate of 2 pounds; chlordane, one pound; or aldrin at one-half pound controlled grasshoppers.

MEADOW SPITTLEBUG: Spittlebug adults have not been found to damage alfalfa even though populations may be very high. Initial control without residual effect was obtained with per acre dosages of 1.5 pounds of DDT, 2 pounds of methoxychlor, 2 pounds of toxaphene, 0.5 pound of BHC, 0.25 pound of lindane, 0.5 pound of dieldrin, and 0.5 pound of parathion.

In only one experiment (table VII) were residual effects of insecticides against adult spittlebugs evident. Residual effects persisted four weeks after treatment with per acre dosages of 1 pound of dieldrin, 2 to 3 pounds of DDT, or combinations of 1 pound of DDT with 1 pound of toxaphene or 1 pound of dieldrin.

HARVEST DATA: Data for experiments 1 and 2 on seed yields are not included. Although significant differences were found in these experiments, there was considrable variability due to harvesting problems encountered. Much seed was lost due to unfavorable weather and the presence of black stem disease, *Ascochyta imperfecta.*

The effect of insect control in seed production can be noted by studying the tables for experiments 3, 4, and 5. All treatments effecting insect control increased seed yields. In experiment 3, seed yields were increased from 0.4 bushel to 1.5 bushels of cleaned seed; in experiment 4, from 0.4 bushel to 1.75 bushels; and in experiment 5, from 0.4 to 1.5 bushels. Highest yields have been obtained with treatments of 1.75 to 3 pounds of DDT per acre or a combination of 1 pound of DDT and 0.5 to 1 pound of dieldrin.

Harvest data also included sampling each plot to determine injury to racemes due to insects and the amount of pollination effected as evidenced by racemes producing pods and the total pods produced. The percentage of racemes aborted may seem high on the better treatments. This is partially due to the severity of the rating. Even though a raceme might bear pods of seed, if there was any indication that any portion of that raceme had been injured, it was placed in the aborted column, since a perfect treatment was desired.

CORRELATION OF DATA: Alfalfa seed yields were largely conditioned by the per cent of aborted racemes produced. In experiment 3, the treatment correlation between seed yields and aborted racemes was —0.853; in experiment 4, it was —0.787. The per cent of racemes aborted may be influenced by either plant bugs or leafhoppers depending on the populations. In experiment 1, a highly significant treatment correlation of 0.93 and in experiment 2, of 0.96 between per cent aborted racemes and the number of plant bug nymphs was obtained. There was no correlation between the number of leafhoppers and per cent aborted racemes. However, in experiment 5 where plant bugs were scarce a positive correlation of .952 between leafhoppers and the per cent of aborted racemes was obtained.

A considerable number of correlations were made in experiment 5, and can be studied in table IX.

Correlations were obtained as follows:

1. Seed yield correlated positively with the number of pods per 100 racemes and with the number of honey bees present.

2. Seed yield correlated negatively with leafhoppers and spittlebugs.

3. The per cent of racemes aborted correlated positively with leafhoppers and negatively with seed yields and honey bees. This latter correlation suggests that honey bees were attracted to the plots having the least number of aborted racemes or the best flowers resulting in increased seed yields or a positive correlation between seed yield and honey bees as previously mentioned.

4. There was a negative correlation between spittlebug adults and the seed yield. However, partial correlations for insects and aborted racemes were made. A significant partial correlation independent of the effects of other insects was obtained with leafhoppers and per cent aborted racemes, but when the per cent aborted racemes was compared with spittlebugs independent of the effects of leafhoppers and plant bugs the correlation was not significant. This indicated that the spittlebugs were present, but the leafhoppers were doing the damage.

TABLE I

Experiment 1. Westpoint, Indiana, 1949—Effect of Insecticides Applied to Alfalfa.

Treatment	Insects Per Twenty Sweeps								
	Leafhoppers		Plant Bug Adults		Plant Bug Nymphs		Spittle Bugs		Grasshoppers
	1 wk.	4 wks.	1 wk.	4 wks.	1 wk.	4 wks.	1 wk.	4 wks.	1 wk.
Untreated	40.8	85.5	17.6	28.3	0	95.6	28.3	31.5	9.3
DDT, 2 lb./acre (emulsion)	4.3	30.5	11.6	21.6	0	4.2	18.3	22.1	3.5
DDT, 2 lb./acre (wettable powder)	4.3	25.8	12.3	17.1	0	9.2	19.5	19.0	4.5
DDT, 1 lb. combined with chlordane, .5 lb./acre	7.3	53.6	14.8	23.8	0	12.0	22.1	32.6	2.5
Chlordane, 1 lb./acre	31.2	130.0	16.1	21.0	0	51.8	23.5	26.1	1.3
Methoxychlor, 2 lb./acre	3.3	41.0	16.5	23.8	0	47.2	15.3	28.7	2.1
TDE, 2 lb./acre	8.3	56.3	14.8	19.6	0	22.7	23.0	31.8	4.1
Dieldrin, .5 lb./acre	42.8	131.6	7.1	21.1	0	8.2	15.5	29.3	0.8
Toxaphene, 2 lb./acre	7.2	37.5	13.0	21.8	0	22.7	13.6	19.8	0.0
Parathion, .5 lb./acre (wettable powder)	3.8	29.0	9.1	34.5	0	1.5	16.5	23.3	1.0
Least significant difference									
(5% level)	14.1	35.4	n.s.	n.s.		12.3	8.3	n.s.	3.8
(1% level)	18.8	47.3	n.s.	n.s.		16.4	11.1	n.s.	5.1

n.s.—differences non-significant statistically

TABLE II

Experiment 2. Rossville, Indiana, 1949—Effect of Insecticides Applied to Alfalfa.

Treatment	Insects Per Twenty Sweeps									
	Leafhoppers		Plant Bug Adults		Plant Bug Nymphs		Spittle Bugs		Grasshoppers	
	1 wk.	4 wks.	1 wk.	4 wks.	1 wk.	4 wks.	1 wk.	4 wks.	1 wk.	4 wks.
Untreated	61.4	107.8	74	23.8	0	62.3	38.9	20.4	34.3	9.1
DDT, 2 lb./acre	4.0	6.8	55	25.8	0	10.4	8.3	9.9	23.3	9.2
DDT, 1 lb., and chlordane, 1 lb./acre	7.8	10.4	47	26.3	0	19.0	19.8	10.0	13.3	7.7
Toxaphene, 2 lb./acre	16.0	8.9	49	26.9	0	21.9	14.0	10.3	6.3	8.0
Aldrin, .5 lb./acre	144.0	253.1	56	21.5	0	28.5	39.8	15.0	11.6	3.5
Chlordane, 1 lb./acre	93.0	78.0	63	22.9	0	40.0	39.4	17.5	11.6	4.3
BHC, .5 lb. gamma/acre	62.8	76.9	50	22.9	0	17.9	12.1	7.1	26.3	9.5
CS-645A, .2 lb./acre	32.9	34.8	54	19.4	0	42.6	38.3	15.1	26.1	8.8
Least significant difference										
(5% level)	51.6	81.4	n.s.	n.s.		14.2	14.5	n.s.	13.0	n.s.
(1% level)	68.9	108.8	n.s.	n.s.		19.0	19.4	n.s.	17.4	n.s.

n.s.—differences non-significant statistically

TABLE III

Experiment 3. Westpoint, Indiana, 1950—Effect of Insecticides Applied to Alfalfa.

Treatment	Insects Per Twenty Sweeps						
	Leafhoppers		Plant Bug Adults		Plant Bug Nymphs		Aphids
	1 wk.	4 wks.	4 wks.	7 wks.	4 wks.	7 wks,	1 wk.
Untreated	25.8	62.0	29.2	37.3	17.2	31.3	73.8
DDT, .5 lb./acre	6.2	61.8	11.8	27.3	3.2	25.3	9.4
DDT, 1 lb./acre	11.8	50.2	23.6	47.3	4.4	28.6	10.8
DDT, 1.75 lb./acre	2.6	34.4	25.4	29.3	1.6	5.3	9.4
DDT, 1 lb. and chlordane, 1 lb./acre	9.8	44.2	26.6	24.0	5.4	30.6	10.0
DDT, 1 lb. and toxaphene, 1 lb./acre	7.6	40.2	30.6	30.0	6.2	18.6	7.4
DDT, 1 lb. and dieldrin, .5 lb./acre	4.4	48.0	19.6	20.7	1.8	10.0	10.2
Dieldrin, .5 lb/acre	25.2	84.2	9.6	13.3	0.6	10.0	54.8
Dieldrin, 1 lb./acre	33.6	75.6	4.6	8.0	0.4	1.3	28.0
Least signicant difference							
(5% level)	11.4	n.s.	n.s.	20.5	6.4	16.0	28.1
(1% level)	15.4	n.s.	n.s.	29.8	8.6	23.4	37.8

n.s.—non-significant statistically

TABLE IV

Experiment 3. Westpoint, Indiana, 1950 (companion table to table 3)
The Effect of Insect Control on Alfalfa Seed Production

Treatment	Raceme Data			Seed Yield	
	Percent Aborted	Racemes With Pods Per Stem	Total Pods Per Stem	Grams Per 60 Sq. Ft.	Pounds Per Acre
Untreated	87.8	12.5	30.8	15.6	25
DDT, .5 lb./acre	71.8	21.7	69.7	28.7	46
DDT, 1 lb./acre	73.7	17.2	50.2	18.7	30
DDT, 1.75 lb./acre	65.1	21.3	78.1	50.3	80
DDT, 1 lb., chlordane, 1 lb./acre	75.7	19.5	72.9	31.7	51
DDT, 1 lb./acre toxaphene, 1 lb./acre	62.8	18.4	63.1	35.9	57
DDT, 1 lb./acre dieldrin, .5 lb./acre	50.7	19.4	72.1	58.1	93
Dieldrin, .5 lb./acre	84.9	17.0	52.5	30.5	49
Dieldrin, 1 lb./acre	75.9	21.6	65.2	33.7	54
Least significant difference (5% level)	9.6	4.9	26.3	25.0	
(1% level)	13.2	n.s.	n.s.	n.s.	

n.s.—non-significant statistically

TABLE V
Experiment 4. Purdue Sand Field, Culver, Indiana—1950
Effect of Insecticides Applied to Alfalfa

Treatment	Insects Per Twenty Sweeps						
	Leafhoppers		Total Plant Bugs		Aphids		Spittle Bugs
	1 wk.	4 wks.	1 wk.	4 wks.	1 wk.	4 wks.	1 wk.
Untreated	45.4	189.3	28.0	16.6	115.8	53.3	95.0
DDT, 3 lb./acre	7.8	42.6	9.6	4.6	5.8	9.3	36.2
DDT, 1.5 lb./acre	8.4	51.3	10.8	8.0	5.2	37.3	50.4
Toxaphene, 3 lb./acre	19.6	107.3	14.4	4.6	32.2	329.6	40.0
Lindane, .25 lb./acre	32.6	263.3	12.8	10.0	19.8	152.6	44.4
Lindane, .5 lb./acre	35.4	379.3	8.8	21.3	4.0	42.6	29.6
Dieldrin, .5 lb./acre	38.6	517.3	9.8	8.0	132.8	302.0	44.6
EPN, .5 lb./acre	23.6	261.3	25.4	29.3	80.8	163.3	75.8
Parathion, .5 lb./acre	10.4	128.0	13.8	24.6	2.6	50.0	53.0
Parathion, 1 lb./acre	10.8	134.0	14.2	19.3	4.6	16.6	56.4
Least significant difference (5% level)	19.2	135.1	9.9	12.1	54.8	185.2	29.1
(1% level)	25.8	185.0	13.4	16.6	73.6	253.7	39.0

TABLE VI

Experiment 4. Purdue Sand Farm, Culver, Indiana, 1950 (companion table to table 5)
The Effect of Insect Control on Alfalfa Seed Production

Treatment	Raceme Data			Seed Yield	
	Percent Aborted	Racemes With Pods Per Stem	Total Pods Per Stem	Grams Per 60 Sq. Ft.	Pounds Per Acre
Untreated	91.5	4.3	10.5	19.8	32
DDT, 3 lb./acre	64.8	5.3	18.5	67.8	108
DDT, 1.5 lb./acre	63.0	5.7	18.0	52.8	84
Toxaphane 3 lb./acre	82.1	5.0	14.3	18.1	29
Lindane 0.25 lb./acre	89.4	3.9	9.8	25.2	40
Lindane 0.5 lb./acre	85.0	3.8	1.1	26.5	42
Dieldrin 0.5 lb./acre	75.7	6.3	19.8	50.9	81
EPN 0.5 lb./acre	90.6	3.9	10.0	10.6	17
Parathion 0.5 lb./acre	73.6	4.6	15.9	41.0	66
Parathion 1 lb./acre	74.5	5.0	15.3	29.3	47
Least significant difference (5% level)	10.0	n.s.	6.3	17.2	
(1% level)	13.8	n.s.	n.s.	23.5	

n.s.—difference—statistically non-significant

TABLE VII

Experiment 5. Purdue Sand Field, Culver, Indiana, 1951
Effect of Insecticides Applied to Alfalfa

Treatment	Insects Per Twenty Sweeps							
	Leafhoppers		Plant Bugs		Aphids		Spittle Bugs	
	1 wk.	4 wks.	1 wk.	4 wks.	1 wk.	4 wks.	1 wk.	4 wks.
Untreated	88	109	9.2	6.0	65	123	252	158
DDT, 3 lb./acre	6	7	10.8	7.2	4	10	158	97
DDT, 2 lb./acre	15	10	6.8	6.8	48	9	217	111
DDT, 1 lb./acre and toxaphene, 1 lb./acre	26	18	8.8	7.6	50	22	190	97
DDT, 1 lb./acre and dieldrin, 1 lb./acre	20	18	2.0	4.0	6	5	124	88
DDT, 1 lb./acre and dieldrin, .5 lb./acre	22	15	4.8	10.8	0	10	196	98
Dieldrin, 1 lb./acre	120	153	1.2	6.0	14	34	139	111
Systox, 1 lb./acre	18	22	4.8	6.4	10	2	224	142
Systox, .5 lb./acre	41	42	7.2	9.6	4	4	258	122
Least significant difference (5% level)	23	49	6.1	n.s.	18	27	63	37
(1% level)	31	65	8.2	n.s.	24	36	84	50

n.s.—differences non-significant statistically

TABLE VIII

Experiment 5. Purdue Sand Farm, Culver, Indiana, 1951 (companion to table 7) The Effect of Controlling Injurious Insects of Alfalfa on Honey Bees and Seed Production.

Treatment	Honey Bees Per 20 Sweeps Full Bloom	Raceme Data		Seed Yields	
		Percent Aborted	Rods Per 100 Racemes With Pods	Grams Per 81 Sq. Ft.	Pounds Per Acre
Untreated	9.6	67	237	21.5	25
DDT, 3 lbs./acre	19.2	33	255	45.2	54
DDT, 2 lbs./acre	13.6	31	267	52.0	62
DDT, 1 lb., toxaphene, 1 lb./acre	11.2	33	258	41.4	49
DDT, 1 lb., dieldrin, .5 lb./acre	16.0	35	276	45.1	53
DDT, 1 lb., dieldrin, 1 lb./acre	16.0	34	305	58.0	69
Dieldrin, 1 lb./acre	7.2	66	244	30.5	36
Systox, 1 lb./acre	14.0	40	246	35.7	42
Systox, .5 lb./acre	8.8	49	257	27.4	32
Least signficant difference (5% level)	6.9	13	38	16.7	
(1% level)	n.s.	18	51	20.9	

n.s.—non-significant statistically

TABLE IX

Experiment 5. Purdue Sand Field, Culver, Indiana, 1951 Correlation Coefficients Associated With Seed Yield, Damage, Injurious Insects, and Honey Bees

	Seed Yield	Pods Per 100 Racemes With Pods	Percent Racemes Aborted	Leaf-hoppers	Spittle bugs	Plant Bugs	Honey Bees
Seed Yield	xxx	.839**	—.832**	—.684*	—.769*	—.191	.728*
Pods Per 100 Racemes With Pods	+.839**	xxx	—.618	.....	.....	.....	.512
Percent Racemes Aborted	—.832**	—.618	xxx	.952**	.632	—.169	—.760*
Leafhoppers	—.684*	.....	.952**	xxx	—.639	—.045	.....
Spittlebugs	—.769*	.....	.632	—.639	xxx	—.085	.....
Plant Bugs	—.191	.....	—.169	—.045	—.085	xxx	.....
Honey Bees	.728*	.512	—.760*	.....	.....	.....	xxx

* Statistically Significant
** Statistically Highly Significant

TABLE X

Summary of Toxic Action of Various Treatments on Insect Populations on Alfalfa; Data of All Experiments Averaged and Converted to Numerical Ratings from 1-9.

Key to Ratings

1—very high toxicity
2—high toxicity
3—fair toxicity
4—above average toxicity
5—average toxicity
6—below average toxicity
7—little toxicity
8—very little toxicity
9—no toxicity

Insecticide—Pounds Per Acre	Leafhoppers		Plant Bugs	Aphids		Grasshoppers
	Initial Kill	Residual Effect	Residual Effect	Initial Kill	Residual Effect	Initial Kill
Aldrin 0.5	9	9*	4	—	—	2
BHC 0.5 gamma	9	9	2	—	—	7
Chlordane 1.0	8	9*	5.5	—	—	2
DDT 0.5	2	9	3	1	—	—
DDT 1.0	2	6	3	1	—	—
DDT 1.5	1	1.5	3	1	6	—
DDT 1.75	1	1	1.5	1	—	—
DDT 2.0	1	1	1.2	—	—	5
DDT 2.0 (wettable powder)	1	1	1.5	—	—	5
DDT 3.0	1	1	1	1	1	—
DDT 1.0 & toxaphene 1.0	3	2.5	4	1	—	—
DDT 1.0 & dieldrin 1.0	2.5	2.0	1.5	—	—	—
DDT 1.0 & dieldrin 0.5	2.2	3.3	—	1	—	—
DDT 1.0 & chlordane 1.0	2.3	2.7	3	1	—	—
DDT 1.0 & chlordane 0.5	2.0	5.0	2	—	—	3
Dieldrin 0.5	9	9*	3	8	9*	1
Dieldrin 1.0	9	9*	1	4	—	—
EPN 0.5	4	9*	9*	6.5	9*	—

TABLE X (Continued)

1—very high toxicity
2—high toxicity
3—fair toxicity
4—above average toxicity
5—average toxicity
6—below average toxicity
7—little toxicity
8—very little toxicity
9—no toxicity

Insecticide—Pounds Per Acre	Leafhoppers		Plant Bugs	Aphids		Grasshoppers
	Initial Kill	Residual Effect	Residual Effect	Initial Kill	Residual Effect	Initial Kill
Lindane 0.25	6	9*	5	3	9*	—
Lindane 0.5	6	9*	9*	1	7	—
Methoxychlor 2.0	1	3	5	—	—	3
Parathion 0.5	2	6	9	1	9	2
Parathion 1.0	1.5	6	9	1	2	—
Systox 0.5	5	4	—	—	—	—
Systox 1.0	2	2	—	—	—	—
TDE 2.0	2	5	3	—	—	5
Toxaphene 3.0	3	4.5	1	4	9*	—
Toxaphene 2.0	3	4.5	3	—	—	—

* Insect populations tend to build up higher than untreated
— No information

Summary and Conclusions

Studies over a period of five seasons (one of which was reported in 1949 and three of which are reported in this paper) show that insect control is one of the most important factors in alfalfa seed production. A single pre-bloom spray has increased seed yields from 0.4 to 1.75 bushels of cleaned seed per acre. This was done by controlling the potato leafhopper, *Empoasca fabae* (Harris) and three species of plant bugs: *Lygus oblineatus* (Say), *Adelphocoris lineolatus* (Goez), and *A. rapidus* (Say). Research in progress to be reported at a later date suggests that considerable damage is effected by insects before the prebloom spray is applied and that a complete insect control program may include as many as three treatments applied early, prebloom, and in full bloom. These multiple treatments increased the yield considerably over the single prebloom treatment.

If only one spray is to be applied during the season, a long residual spray is required. For this purpose a per acre dosage of a combination of 1 pound of DDT and 0.5 to 1 pound of dieldrin, or 2 to 3 pounds of DDT alone have given the best results.

Although a yield of 1.75 bushels of cleaned alfalfa seed may seem low, this amount would be profitable to Indiana farmers at the present high cost of seed. Newer selections being studied show promise of being heavy seed producers and it is believed that when selections are ready for release alfalfa seed yields can be increased greatly in the State.

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