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Alfalfa Weevil Control with Granular Insecticides and the Occurrence of Residues

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The alfalfa weevil, Hypera postica (Gyll.) is the most serious pest of alfalfa and one of the most important insects in North Carolina. If alfalfa is to be grown and maintained, control of the weevil is essential. Poor control of the weevil can result in the loss of the first cutting, reduced second cutting, or loss of the stand.

Weevil populations in North Carolina far surpass those reported in South Dakota and New York and are somewhat higher than those reported in Maryland. Five sweepings with a 15-inch sweep net will yield an average of 300 to 350 larvae in untreated fields.

Protection of the stand of alfalfa against populations such as those occurring in this state is extremely difficult with the use of sprays for larval control. Control of the adults with the currently suggested spring applications of sprays necessitates multiple treatments. Because of the differences existing in population density of weevils, spray equipment and timing of sprays, results in this state have been erratic and often poor with multiple spray applications.

Due to the poor control and severity of weevil damage, many farmers have plowed under their alfalfa. This measure, however, will not solve the weevil problem since this insect also attacks the clovers. Although the weevil prefers alfalfa, in the absence of this crop, the weevil will probably move to clover. Fields of clover adjacent to alfalfa fields have incurred up to 50 per cent damage.

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The best control of the weevil can be obtained not by treatments directed against the larvae but by preventing the establishment of adult weevils and thereby preventing egg laying and the damaging spring larval populations.

Seasonal history studies of the weevil in North Carolina suggested fall application of granular insecticides might be effective in preventing the establishment of adult weevils. In view of the recent restrictions on heptachlor usage, successful control with fall applications offers a possibility of salvaging this most effective weevil control.

Field Methods

Seasonal history records of the weevil were taken by sampling alfalfa fields in several counties in Piedmont North Carolina. Adult weevils were collected by taking 100 net strokes with a 15-inch sweep net every 7 to 10 days in selected fields. Egg counts were made by splitting 20 stems from each sampled field.

Three established fields of alfalfa located in two counties in Piedmont North Carolina were selected for experimental plots. Granular heptachlor (2½%) and granular dieldrin (2%) were applied at the rate of one pound active ingredient per acre and granular toxpahene (25%) was applied at the rates of 10 and 20 pounds active ingredient per acre. Granular insecticides were applied to the 12-feet wide by 50-feet long plots with a hand-operated Gandy fertilizer spreader.

Dieldrin and heptachlor were applied on October 15 and November 14, 1959 and February 1 and 20, 1960. Each material and date of application was replicated four times at three locations. Each plot received only one application of insecticide for each pre-determined date. Toxaphene was applied on February 20, 1960 at only one location.

Control of the weevil was determined by larval counts and damaged plants. Larval counts were determined by taking five sweeps with a 15-inch sweep net in each plot. Damage evaluations were made by counting all weevil-damaged plants in four, one-square-foot samples in each replicated plot. A plant was counted as damaged if only a single leaf showed any weevil injury. This was a rather severe evaluation. Damage counts were taken four to seven days prior to normal first crop cutting.

Samples of alfalfa were collected for each treatment date at the three locations for residue determinations. Since the plots were small, regular harvesting methods could not be employed due to inter-plot contamination. A fifteen-foot swath was taken out of the center of each plot using a Tornado gasoline powered mowing machine with a three-foot blade set three inches above the ground. Samples were collected on May 6 in accordance with normal harvesting of the first crop of alfalfa. Two sets of samples were taken for residue analysis. In one set of samples the alfalfa was cut, allowed to fall to the ground, and picked up without raking. Another sample was taken by raking vigorously with a garden rake the cut alfalfa, litter and any dislodged soil into a pile. The raked alfalfa and accumulations of debris were carefully placed in a kraft bag for residue determination. A composite sample was taken from the four replicated plots for residue analysis.

The field samples were chopped in a Hobart cutter and duplicate 100-gram laboratory subsamples were taken for analysis.

Analytical Methods

Analytical procedure used for the determination of heptachlor was based on the method of Polen, P. B., Silverman, P., Anal Chem. 24:733 (1952), as modified by Ordas, E. P., Smith, U. C., Meyer, C. F., J. Agr. Food Chem. 4: 444 (1956).

The procedure used for the determination of heptachlor epoxide was based on the method set forth in the paper, "Tentative method for heptachlor epoxide on alfalfa, Revision I (11/11/58)," Velsicol Chemical Corp., Chicago, Illinois.

Color measurements were made on a DK-2 Beckman Ratio Recording spectrophotometer, and absorbance readings were taken at positive peaks of 560 mμ and 410 mμ indicative of heptachlor and heptachlor epoxide respectively. Data were interpreted utilizing suggestions set forth by Meyer, C. F., Malina, M. H., Polen, P. B., J. Agr. Food Chem. 8(3): 183 (1960).

Results and Discussion

Seasonal history studies of the alfalfa weevil show the weevil leaves the alfalfa fields during the summer and estivates in orchard grass, ditch banks, and woods. From these shaded habitats the weevil moves back into the field in September, gradually increases in number in October, and reaches a peak in November and December. Egg laying commences in Mid-November ceasing with the approach of low temperatures and commencing during the early spring. The damaging spring larval populations result from these fall and spring-laid eggs. Weevil adult and egg counts for the fall, 1959, are shown in table 1.

Control of the weevil, based upon collected larvae, revealed that, in fact, fall treatment was more effective than the previously recommended February treatment. This is more readily apparent with dieldrin which was not as effective as heptachlor. Heptachlor was superior to dieldrin while toxaphene provided little protection to the alfalfa (Table 2). The treatments were so effective in preventing the establishment of adults in the field that check plots were only lightly infested; in fact four times as many larvae were collected in untreated alfalfa adjacent to the test plots at Bridges' Farm than were collected from checks within the test. What is even more striking is that twice as many larvae were collected from adjacent plots three weeks after one application of malathion or methoxychlor than were collected in these checks.

Sweepings, taken near harvest time of the alfalfa, showed a marked drop in collected larvae. Heavy pupation was observed in the untreated check plots. The trend for better control with fall treatment is nevertheless apparent (Table 3).

Because of the relatively light to moderate infestation in the plots in an otherwise heavily infested field, a more critical method of evaluation of control was needed. Damage evaluation by the square-foot-sample method showed clearly the true beauty of the fall treatment. Near perfect control was obtained at three locations with granular heptachlor applied on October 15. Dieldrin provided excellent control in the fall but only fair to good control in February (Table 4). Although the number of weevil-damaged plants approached 100 per cent in the checks, overall foliage damage was far below this figure. Damage counts were not taken in the toxaphene-treated plots since all plants exhibited weevil damage; in fact, there was no difference in the amount of weevil damage in plots treated with toxaphene and the untreated check plots.

Residue determinations made from cut and raked samples of alfalfa are shown for dieldrin-treated plots in table 5. Detectible residues of dieldrin were obtained for all treatment dates at the three locations when the first cutting of alfalfa was raked. No detectible residues were obtained from fall-treated, cut alfalfa. Only after a lapse of 217 days from treatment and after high summer temperatures did dieldrin residues dissipate below detectibility in the raked, second cutting.

Heptachlor and heptachlor epoxide residues for the three locations and treatment dates are shown in table 6. Cut samples of alfalfa at all treatment dates failed to show detectible residues of heptachlor or heptachlor epoxide employing the described analytical methods of analysis. Raked samples showed low level residues of heptachlor and its epoxide in November and February treatments. First cutting, raked samples obtained from the October 15 application failed to show detectible residues of heptachlor but a trace of the epoxide was recovered from the Steed test. The Dairy and Bridges tests were recorded as negative for epoxide. Second cutting, raked samples obtained from the Bridges test failed to show detectible residues of heptachlor and heptachlor epoxide when heptachlor was applied on October 15.

Cut, crushed, and baled alfalfa, treated in February, 1959 but not in 1960, was negative for heptachlor and its epoxide when residue determinations were made on the 1960-baled second cutting.

The data presented in this report clearly demonstrate the superior control of the alfalfa weevil with October 15 application of granular heptachlor. Furthermore, it can be interpreted from the results that heptachlor applied in the fall prevents the establishment of adult weevils and for practical purposes, eliminates egg deposition.

These data further suggest a means of utilizing a most effective control of the alfalfa weevil by the timing of application sometime between October 1 and October 15, employing a cyclone seeder or a good fertilizer spreader which can be accurately calibrated to apply granular heptachlor not exceeding one pound active ingredient per acre.

Table 1. Seasonal history studies of the alfalfa weevil in Piedmont North Carolina, in the fall, 1959.

Month	No. 100 stroke samples	Av. No. Adults 100 net strokes	Av. No. eggs per stem
Sept.	19	.5	0
Oct.	26	4.6	0
Nov.	22	17.1	.7
Dec.	20	17.2	1.7

Table 2. Alfalfa weevil control with granular insecticides. Piedmont North Carolina, 1959-1960.

Treatment and application date	Lb. P/A active ingred.	Total larvae collected per 20 net strokes in replicated plots. Bridges Farm April 20	Dairy Farm April 21
Heptachlor	1		
Oct. 15		0	4
Nov. 14		0	2
Feb. 1		0	49
Feb. 20		0	16
Dieldrin	1		
Oct. 15		2	8
Nov. 14		2	24
Feb. 1		27	124
Feb. 20		27	91
Untreated	-	245	611
Toxaphene			
Feb. 20	10	-	586
Feb. 20	20	-	563
Untreated	-	-	812

Table 3. Alfalfa weevil control with granular insecticides. Piedmont North Carolina, 1959-1960.

Treatment and application date	Lb. P/A active ingred.	Total larvae collected per 20 net strokes in replicated plots[A]		
		Bridges Farm May 2	Steed Farm April 29	Dairy Farm April 30
Heptachlor	1			
Oct. 15		0	0	1
Nov. 14		0	1	2
Feb. 1		0	1	2
Feb. 20		0	3	3
Dieldrin	1			
Oct. 15		0	0	2
Nov. 14		0	6	2
Feb. 1		1	12	7
Feb. 20		3	4	9
Untreated	-	22	90	130

A/ Pupation high in check plots

Table 4. Weevil damage to alfalfa treated with granular insecticides. Piedmont North Carolina, 1959-1960.

Treatment and application date	Lb. P/A active ingred.	Damaged plants in 16, one-square-foot samples taken in replicated plots		
		Bridges Farm May 2	Steed Farm April 29	Dairy Farm April 30
Heptachlor	1			
October 15		0	3	1
November 14		0	7	5
February 1		5	40	68
February 20		8	16	37
Dieldrin	1			
October 15		2	4	18
November 14		10	36	20
February 1		76	222	226
February 20		135	119	222
Untreated	-	549	423	440

Table 5. Dieldrin residues on alfalfa.

		Treatment dates			
		A 10/15/59	B 11/14/59	C 2/1/60	D 2/20/60
		Sampling dates			
		5/6/60	5/6/60	5/6/60	5/6/60
		Elapsed days			
		204	175	95	76
1st cutting	Lb. P/A	P.P.M. Dieldrin[a,b]			
Dairy, cut		Neg.*	Neg.	0.26	0.10
Dairy, raked	1	0.20	0.38	0.24	0.45
Steed, cut		Neg.	Neg.	Neg.	Neg.
Steed, raked	1	0.11	0.19	0.22	0.27
Bridges, cut		Neg.	Neg.	0.11	0.78
Bridges, raked	1	0.29	0.52	0.48	1.20
2nd cutting		Sampling dates			
		6/17/60	6/17/60	6/17/60	6/17/60
		Elapsed days			
		246	217	137	117
	Lb. P/A	P.P.M. Dieldrin[a,b]			
Bridges, cut		Neg.	Neg.	Neg.	Neg.
Bridges, raked	1	Neg.	Neg.	0.10	0.10

a/ All samples check corrected
b/ Sensitivity level 0.05 P.P.M.
* Less than 0.05 P.P.M.

Table 6.

HEPTACHLOR AND HEPTACHLOR EPOXIDE RESIDUES ON ALFALFA

		Treatment Dates				Treatment Dates			
		A	B	C	D	A	B	C	D
		10/15/59	11/14/59	2/1/60	2/20/60	10/15/59	11/14/59	2/1/60	2/20/60
		Sampling Dates				Sampling Dates			
		5/6/60	5/6/60	5/6/60	5/6/60	5/6/60	5/6/60	5/6/60	5/6/60
		Elapsed Days				Elapsed Days			
		204	175	95	76	204	175	95	76
1st Cutting	Lb. P/A	PPM, Heptachlor[a,b]				PPM, Heptachlor[a,b]			
Dairy, cut		Neg.*	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Dairy, raked	1	Neg.	Neg.	.10	.13	Neg.	Neg.	.07	.08
Steed, cut		Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Steed, raked	1	Neg.	.13	.17	.19	.06	.12	.12	.14
Bridges, cut		Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Bridges, raked	1	Neg.	.09	.16	.21	Neg.	.05	.05	.10

2nd Cutting

		Sampling Dates				Sampling Dates			
		6/17/60	6/17/60	6/17/60	6/17/60	6/17/60	6/17/60	6/17/60	6/17/60
		Elapsed Days				Elapsed Days			
		246	217	137	117	246	217	137	117
		PPM, Heptachlor[a,b]				PPM, Heptachlor Epoxide[a,b]			
Bridges, cut		Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	.30
Bridges, raked	1	Neg.	.07	.07	.19	Neg.	Neg.	.16	.33

a/ All samples check corrected
b/ Sensitivity level 0.05 p.p.m.
* Less than 0.05 p.p.m.